INSTRUCTION MANUAL

ARC FUSION SPLICER

FSM-20

FUJIKURA LTD.

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CONTENTS

1. GENERAL

Type FSM-20 Arc Fusion Splicer is used for the splicing SM (Single Mode) type optical fiber and GI (Graded Index) type optical fiber.

The mutual aligning of both SM and GI type optical fiber is done automatically by the image processing of the microcomputer installed in the splicing controller. Additionally the mutual aligning can be done manually by observing both fiber ends on the monitor screen.

The power source applicable for this system is AC90~127V or AC180~254V or DC10~15V.

Fig. 1 and Fig. 2 show the Type FSM-20 Arc Fusion Splicer and its connection diagram, respectively. The type FSM-20 Arc Fusion Splicer includes the splicing controller and the splicer main body. The splicing controller orders all operations to the splicer main body through the controlling cable.

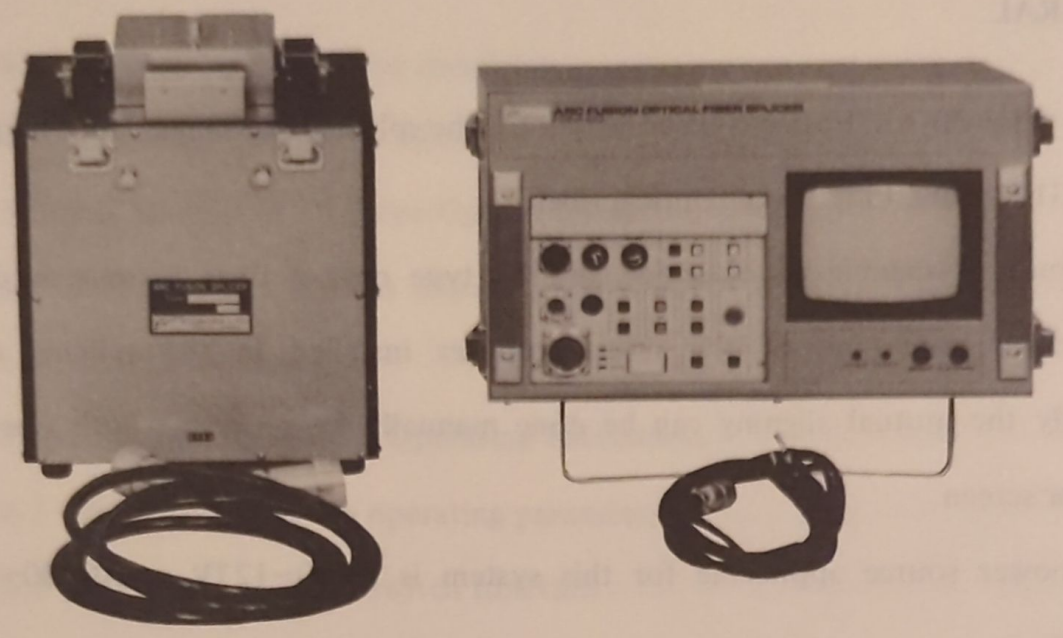


Fig. 1 Type FSM-20 Arc Fusion Splicer

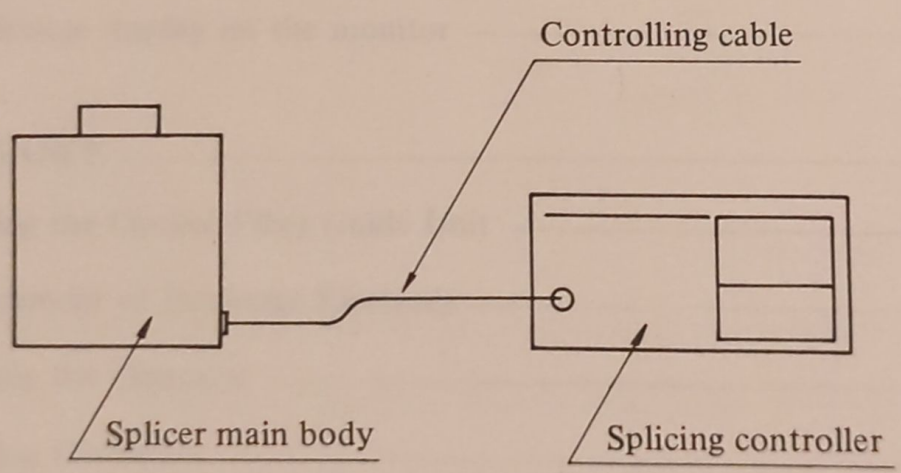


Fig. 2 Connection Diagram

2. CONFIGURATION AND STRUCTURE

2.1 Configuration

The configuration of the Type FSM-20 Arc Fusion Splicer is shown in Table 1 and the complementary goods in Table 2.

Table 1 Configuration of Type FSM-20 Arc Fusion Splicer

No.	Name	Quantity	Ref. Fig.
1	Arc Fusion Splicer Main Body	1	Fig. 3
2	Splicing Controller	1	Fig. 4
3	AC Power Cord	1	Fig. 7
4	Controlling Cable	1	Fig. 8

Table 2 Complementary Goods

Name	Q'ty	Comment
Spare Electrode	1 pair	
Spare Fuse	1 set	Spare for all used
Mirror	1	
Instruction Manual	2	

2.2 Function and Structure

2.2.1 Type FSM-20 Arc Fusion Splicer Main Body

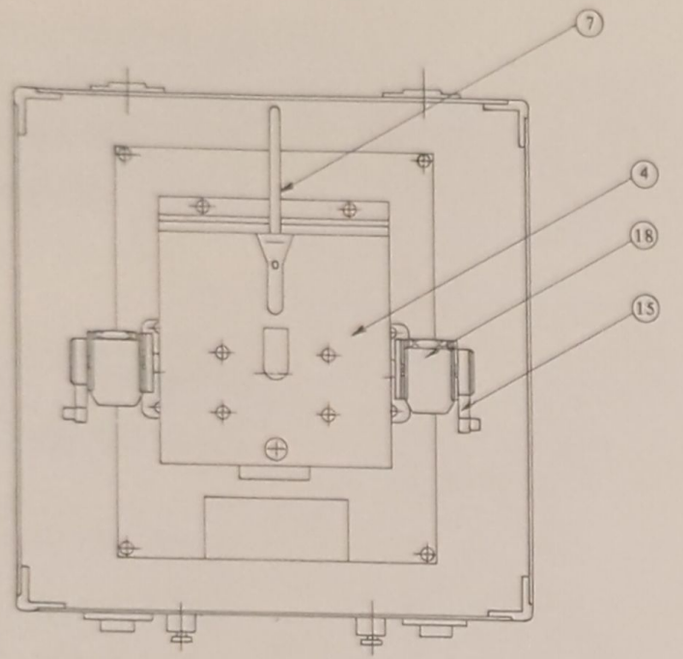
Type FSM-20 Arc Fusion Splicer Main Body (hereafter called Splicer main body) has been developed for optical fiber mutual splicing. These items and their functions are shown in Table 3, and the structure is in Fig. 3.

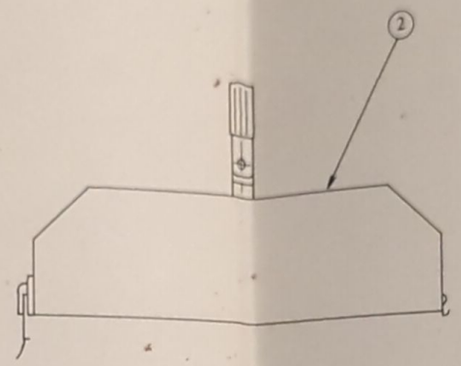
Table 3 The Items and Their Functions of Type FSM-20 Arc Fusion Splicer

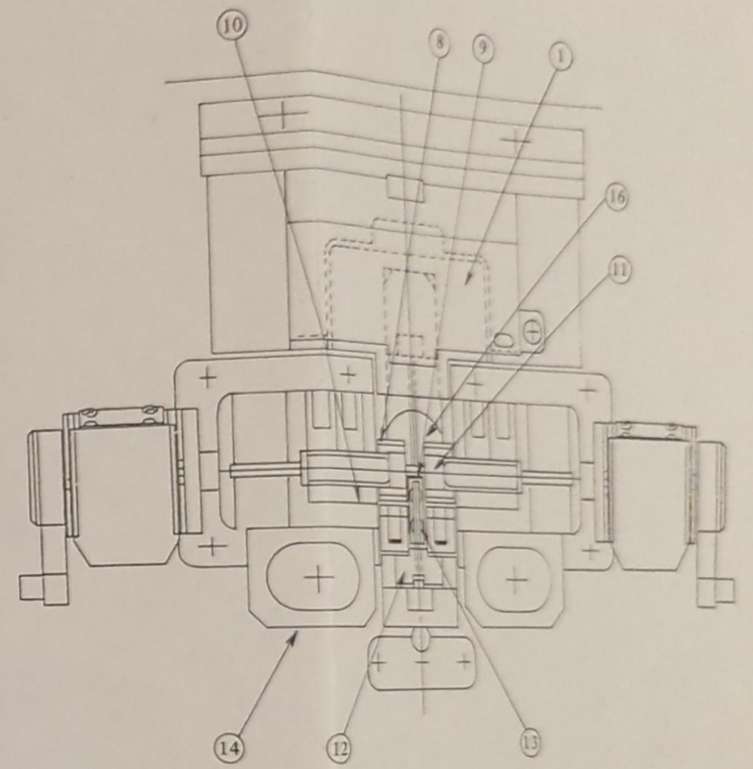
NO.	Nomenclature	Function
①	Electrode Cover	Designed for the insulation of the high voltage electrode. This system does not function when it is removed.
②	Lid	Used to protect the operation panel of the splicer main body.
③	Controlling Cable Terminal	The terminal for connecting the controlling cable.
④	Wind Protector (See NOTE)	Used for the prevention of abnormal discharge which may occur due to wind during discharge. The opening and shutting of the wind protector control the illumination lamp to turn off and on, and the opening of it causes the mirror ⑨ to move down. It also acts as a safety switch for the discharge switch.
⑤	Heater Setting Terminal	Used to install the splice reinforcement tube heater.
⑥	Counter	This counter indicates the number of discharges cumulatively.
⑦	Illumination Lamp	Used to illuminate the optical fiber. When the wind protector ④ is closed, the illumination is turned ON; when it is opened the illumination is turned OFF.
⑧	Optical Fiber Guide Unit	Used to hold the optical fiber and can move in the X and Y directions.

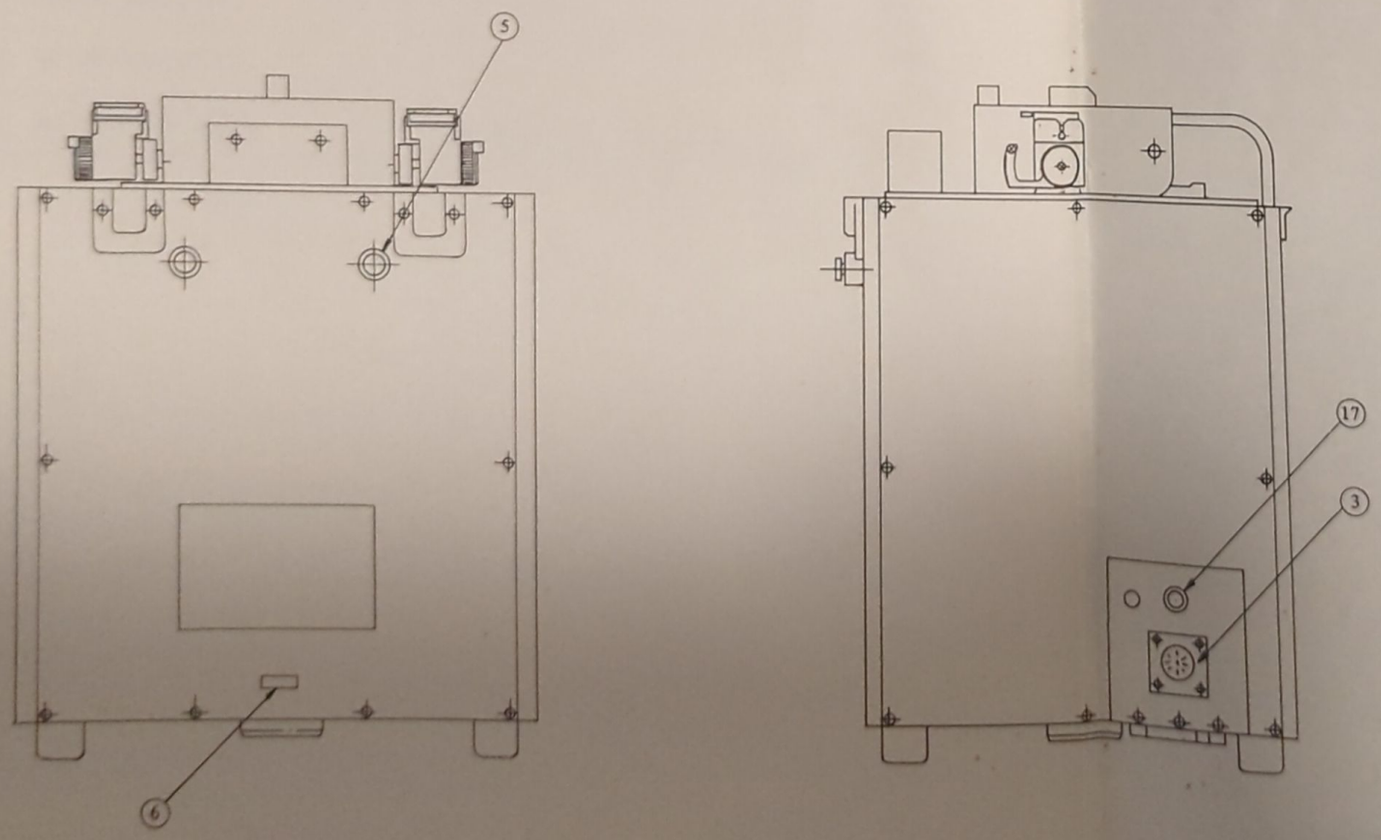
NO.	Nomenclature	Function
⑨	Mirror	Used to conduct the illumination light to the objective, and can be inserted and removed.
⑩	Holder	Used to set the optical fiber in the home position.
⑪	Clamp	Used to place the optical fiber on the optical fiber guide unit ⑧ and the holder ⑩, and it can be opened and closed. (Refer to the handle ⑭ for information on opening and closing).
⑫	Electrode Stator	Used to fix the discharge electrode ⑬ (Fig. 5) in the home position.
⑬	Discharge Electrodes (Refer to Fig. 5)	These produce an electrical discharge used to splice the optical fibers.
⑭	Handle	Used to open and close the clamp ⑪. When you pull the handle toward you, it opens and when you push it backward, it closes.
⑮	Proof Tester Dial	Used to make the proof test.
⑯	Objective	Used to observe magnified fiber image.
⑰	Fuse Holder	The 3A fuse is used.
⑱	Proof Tester Attachment	Used to clamp the fibers and keep under screening stress (about 50 kPSI) after splicing the proof testing of splice.

NOTE:
Push the MIRROR ON switch to move up the mirror ⑨. Push simply the SET/START switch to begin the GAP SETTING. (First, the system automatically moves up the mirror and goes to the next step.)









NO.	Nomenclature	NO.	Nomenclature
1	Electrode cover	11	Clamp
2	Lid	12	Electrode stator
3	Controlling cable terminal	13	Discharge electrode
4	Wind protector	14	Handle
5	Heater setting terminal	15	Proof tester dial
6	Counter	16	Objective
7	Illumination fiber	17	Fuse holder
8	Optical fiber guide unit	18	Proof tester attachment
9	Mirror		
10	Holder		

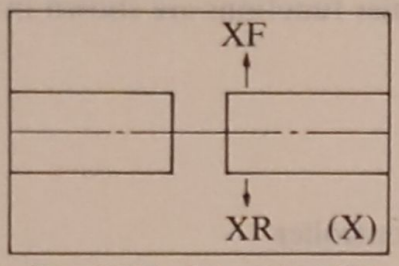
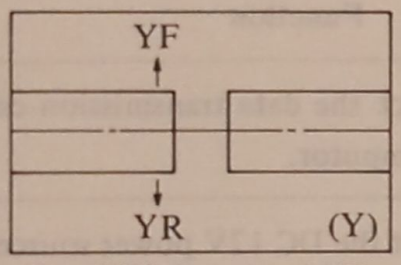
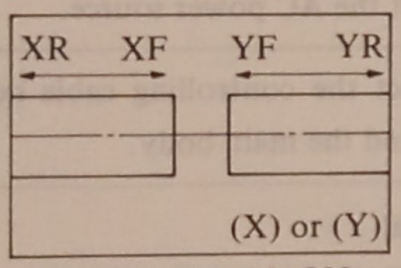
Fig. 3 Type FSM-20 Arc Fusion Splicer Main Body

2.2.2 Type FSM-20 splicing controller

Type FSM-20 splicing controller is connected to the splicer main body and controlls mutual aligning and all other functions. The items and thier functions are shown in Table 4, and the structure is in Fig. 4.

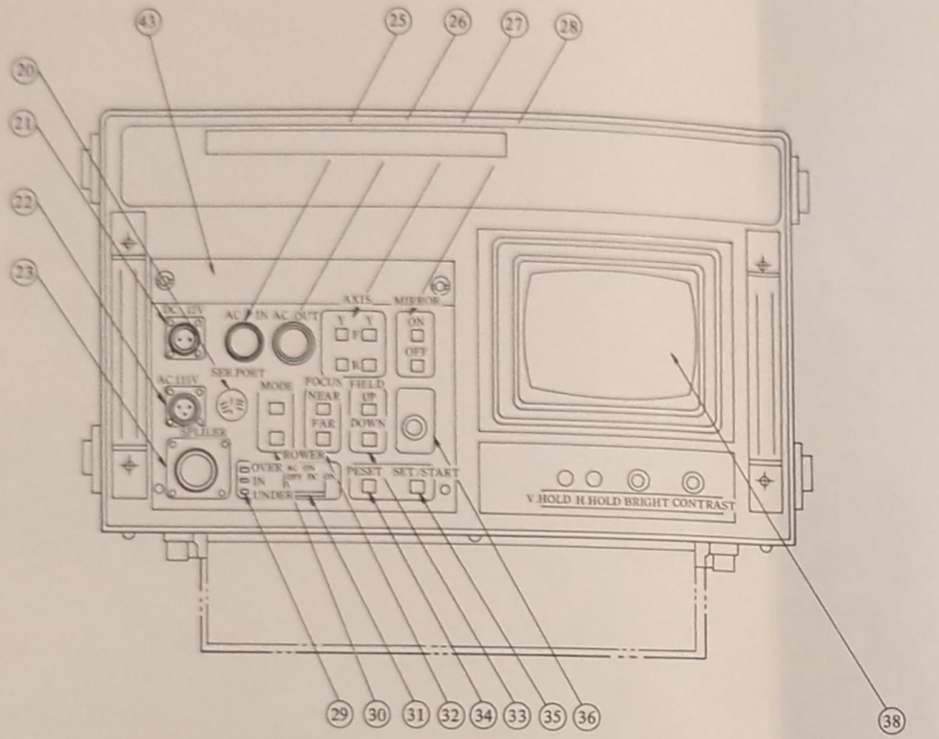
Table 4 Type FSM-20 Splicing Controller

NO.	Nomenclature	Function
⑳	SER.PORT Terminal	Used to connect the data transmission cable of the external computor.
㉑	DC Power Terminal	Used to connect the DC 12V power source.
㉒	AC Power Terminal	Used to connect the AC power source.
㉓	Controlling Cable Terminal	Used to connect the controlling cable between the controller and the main body.
㉔	Ground Terminal	Ground terminal.
㉕	AC IN Fuse Holder	The 3A fuse is used.
㉖	AC OUT Fuse Holder	The 3A fuse is used.

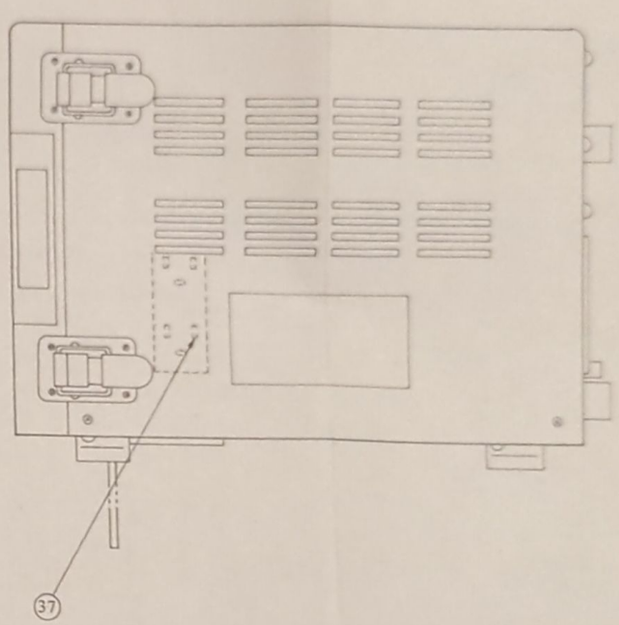
NO.	Nomenclature	Function
㉗	AXIS Switch  Dip SW5 Bit 6 is OFF  Dip SW5 Bit 6 is OFF  Dip SW5 Bit 6 is ON	These switches are used when alignment is to be done manually. These switches have the functions of XF.XR and YF.YR when the Bit 6 of the dip switch 5 is turned OFF. When "(X)" is displayed on the monitor, the right side fiber moves up or down on the monitor when the XF or XR switch is depressed. When "(Y)" is displayed on the monitor TV, the left side fiber moves up or down on the monitor when the YF or YR switch is depressed. When the align movement range is exceeded, the buzzer sounds and the movement automatically reverse back to the initial position. When the Bit 6 of the dip switch 5 is turned ON, XF(R) switch has the function of moving the left side fiber forward (backward) along the Z axis, and the YF(R) switch has the function of moving the right side fiber forward (backward) along Z axis. XF → ZLF, XR → ZLR YF → ZRF, YR → ZRR
㉘	MIRROR Switch	These switches are used to insert or remove the mirror. When the MIRROR ON (OFF) is depressed, the mirror is inserted (removed).
㉙	Input Voltage Indication (AC input only)	Indicates whether the input AC voltage is in, under, or over the appropriate range. When the DC power source is used, be sure to check the source voltage is within 10-15V before applying. If the DC source voltage is within 10-15V, the system works normally even though the "OVER" or "UNDER" is indicated.
㉚	MODE Switch	Used to change the mode to SM or GI. When the changing of the mode is finished, the switch itself lights up. In the SM mode, the core axis alignment is done automatically, and in the GI mode, fiber axis alignment is done automatically.

NO.	Nomenclature	Function
㉛	POWER Switch	Used to turn on and off the power.
㉜	FOCUS Switch	Used to move forward and backward the focus point of the fiber image.
㉝	FIELD Switch	Used to change (X) image to (Y) image or vice versa. When the Bit 5 of the dip switch 5 is OFF, the function is for manual operation, so that the fiber image moves up when the FIELD UP switch is depressed, it moves down during the FIELD DOWN switch is depressed. When the Bit 5 of the dip switch 5 is ON, the function is for the automatic field change operation. In this case when FIELD UP or DOWN switch is pushed, the fiber image is changed (X) to (Y) or (Y) to (X), and the position of the fiber image is adjusted to the center of the monitor, focusing automatically. Automatic position and focus adjustment after the image changed are not done prior to the optical gap being set.
㉞	RESET Switch	Used for the reset operation. When the RESET switch is pushed, the system goes back to the initial state from any step of operation. After the reset operation is completed, "READY" and "(X)" or "(Y)" is displayed on the monitor ㊳.
㉟	SET/START Switch	Used to initiate the gap setting of two fiber end faces and automatic align the fibers. The instructions "GAP SETTING" or "CHECK FIBER S/R?" of "ALIGNING" is displayed on the monitor ㊳ in each step.

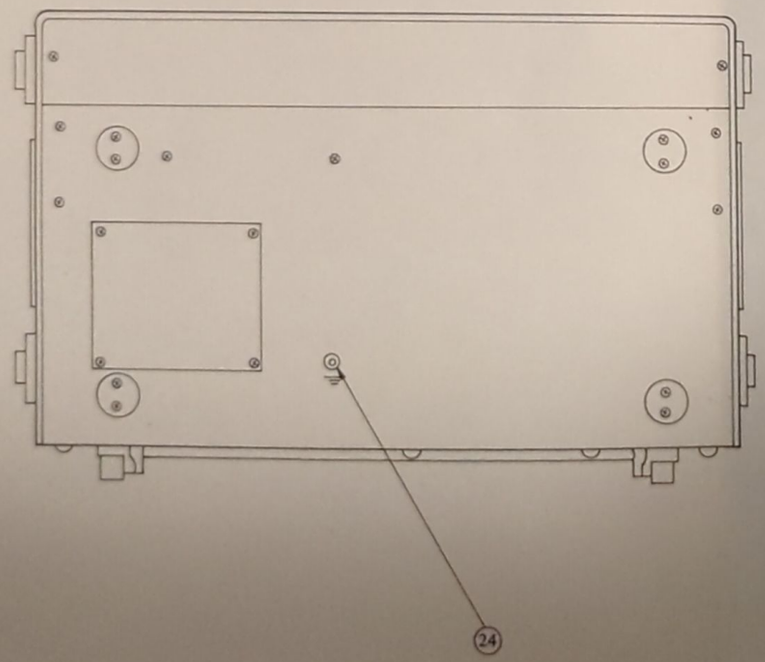
NO.	Nomenclature	Function
㊱	ARC Switch	Used for fusion splicing. This switch does not function while the system is in the automatic splicing operation. From the second discharge or before the gap setting has been completed, the fiber does not move forward along the Z-axis during discharge operation. **ARC** is displayed on the monitor ㉜ just before discharge is produced. If the gap setting is done, the loss estimation automatically follows the discharge operation.
㊲	AC OUT Socket	Used to deliver AC line voltage applied on controller to the external apparatus through 3A fuse. The maximum rating of the sockets is 125V, 15A.
㊳	Monitor	Used to display the fiber image and the operation state and the estimated loss.
㊴	V.HOLD Knob	Used to adjust the vertical synchronization of the monitor ㊳.
㊵	H.HOLD Knob	Used to adjust the horizontal synchronization of the monitor ㊳.
㊶	BRIGHTNESS Knob	This is used to adjust the brightness of the monitor ㊳.
㊷	CONTRAST Knob	This is used to adjust the contrast of the monitor ㊳.
㊸	Dip Switch	These switches are used to set the operating conditions such as discharge time, discharge power, initial gap setting of fiber end faces and so on. Table 5 shows the details of these switches.



Front View



Side View



Rear View

NO.	Nomenclature	NO.	Nomenclature
20	SER.PORT terminal	32	FOCUS switch
21	DC power terminal	33	FIELD switch
22	AC power terminal	34	RESET switch
23	Controlling cable terminal	35	SET/START switch
24	Ground terminal	36	ARC switch
25	AC IN fuse holder	37	AC OUT socket (AC source only)
26	AC OUT fuse holder	38	Monitor
27	AXIS switch	39	V.HOLD knob
28	MIRROR switch	40	H.HOLD knob
29	Input voltage indicator	41	BRIGHTNESS knob
30	MODE switch	42	CONTRAST knob
31	POWER switch	43	Dip switch

Fig. 4 Type FSM-20 Splicing Controller

Table 5 Dip Switch Functions of Type FSM-20 Splicing Controller

Switch No.		Bit	Ex.	Function
Dip Sw 1	LSB	1	1	Time during which the fiber moves forward along Z-axis during discharge,
		2	1	= 10 + DATA x 5 (msec) TFORW
		3	0	Ex. 25 msec = 0 1 1
		4	0	Prefusion time at splicing, PREFUS
		5	0	= 100 + DATA x 20 (msec)
		6	1	Ex. 180 msec = 1 0 0
		7	0	Initial gap of fiber end faces, GAP
	MSB	8	1	= 8 + DATA x 8 (line (2)) Ex. 24 line = 1 0
Dip Sw 2	LSB	1	0	Coefficient of eccentricity correct function (ECFCOF) (3)
		2	0	= 0.05 x DATA
		3	0	Ex. 0.4 = 1 0 0 0
		4	1	
		5	1	Discharge time in SM mode, TARCS
		6	1	= 1000 + DATA x 500 (msec) Ex. 2500 msec = 1 1
		7	0	Discharge time in GI mode, TARCM
	MSB	8	0	= 3000 + DATA Ex. 3000 msec = 0 0
Dip Sw 3	LSB	1	0	Discharge power, ARCPWR
		2	0	Discharge current is approximately
		3	1	12 + 0.3 x DATA (mA)
		4	1	Ex. 15.6mA = 0 1 1 0 0
		5	0	
		6	0	Amount of gap set position shift in (Y) image based on (X) image, CSHIFT
		7	1	= (−1) x x (1 + Bit 8) x 10 x DATA
	MSB	8	0	Ex. −20 line = 0 1 0
Dip Sw 4	LSB	1	0	Time during which focus and field motors move in field change operation
		2	1	= 2000 + 500 x DATA (msec) Ex. 3000 msec = 0 1 0 (TFFM)
		3	0	
		4	1	Time during which focus motor moves additionally in field change opera-
		5	0	tion = 500 + 500 x DATA Ex. 1000 msec = 0 1 (TFM)
		6	0	Gap set position to be adjusted to discharge electrode position in the
		7	0	monitor (ELECTRD)
	MSB	8	1	= 412 + DATA x 25 (line (2)) Ex. 512 = 1 0 0
Dip Sw 5	LSB	1	1	ON or OFF of ECF (Dip Sw 2 Bit 1~4) 1 = ON, 0 = OFF
		2	0	ON or OFF of data display (4) 1 = ON, 0 = OFF
		3	0	ON or OFF of core diameter check (5) 1 = ON, 0 = OFF
		4	1	Selection of operating parameters source 1 = Dip Sw, 0 = BTRAM (1)
		5	1	Selection of FIELD switch function 1 = AUTO, 0 = MANUAL (6)
		6	0	Selection of AXIS switch function 1 = ZL,ZR, 0 = X,Y (7)
		7	0	ON or OFF of short discharge to remove dust 1 = ON, 0 = OFF
	MSB	8	0	ON or OFF of pausing sequence after GAP SETTING 1 = ON, 0 = OFF

NOTE:

(1) The operating conditions of this system can be set either by dip switch 1~5 or by external portable computer connected to SER.PORT terminal. (Refer in detail to 3.8 Operating Method of the Portable computor.)

(2) The monitor (38) has 1024 x 1024 scanning lines. Each line has the resolution of 0.35μm. For example 10 line is equal to 3.5μm.

(3) Refer in detail of ECF to Appendix (A).

(4) Refer to 4 (6) Adjustment method of discharge power.

(5) In case of splicing fibers whose core diameter is smaller than 9μm, this switch should be normally OFF.

(6) Refer to Table 4 (33) FIELD switch.

(7) Refer to Table 4 (27) AXIS switch.

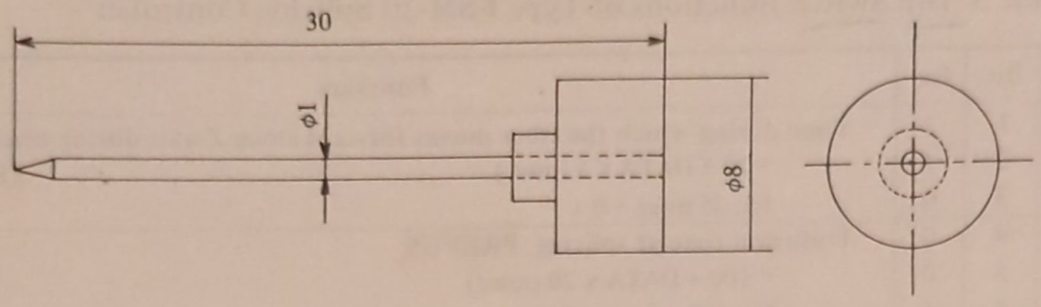
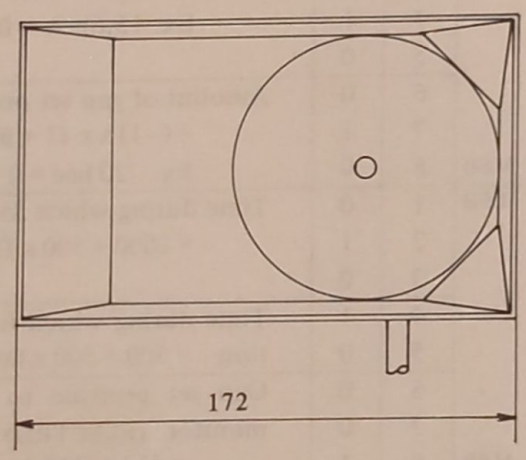


Fig. 5 Discharge Electrode

2.2.3 Ultra-sonic cleaner (optional accessory)

This is used to remove dust on the surface of optical fibers by ultra-sonic wave. Fig. 6 shows its items and its structure.



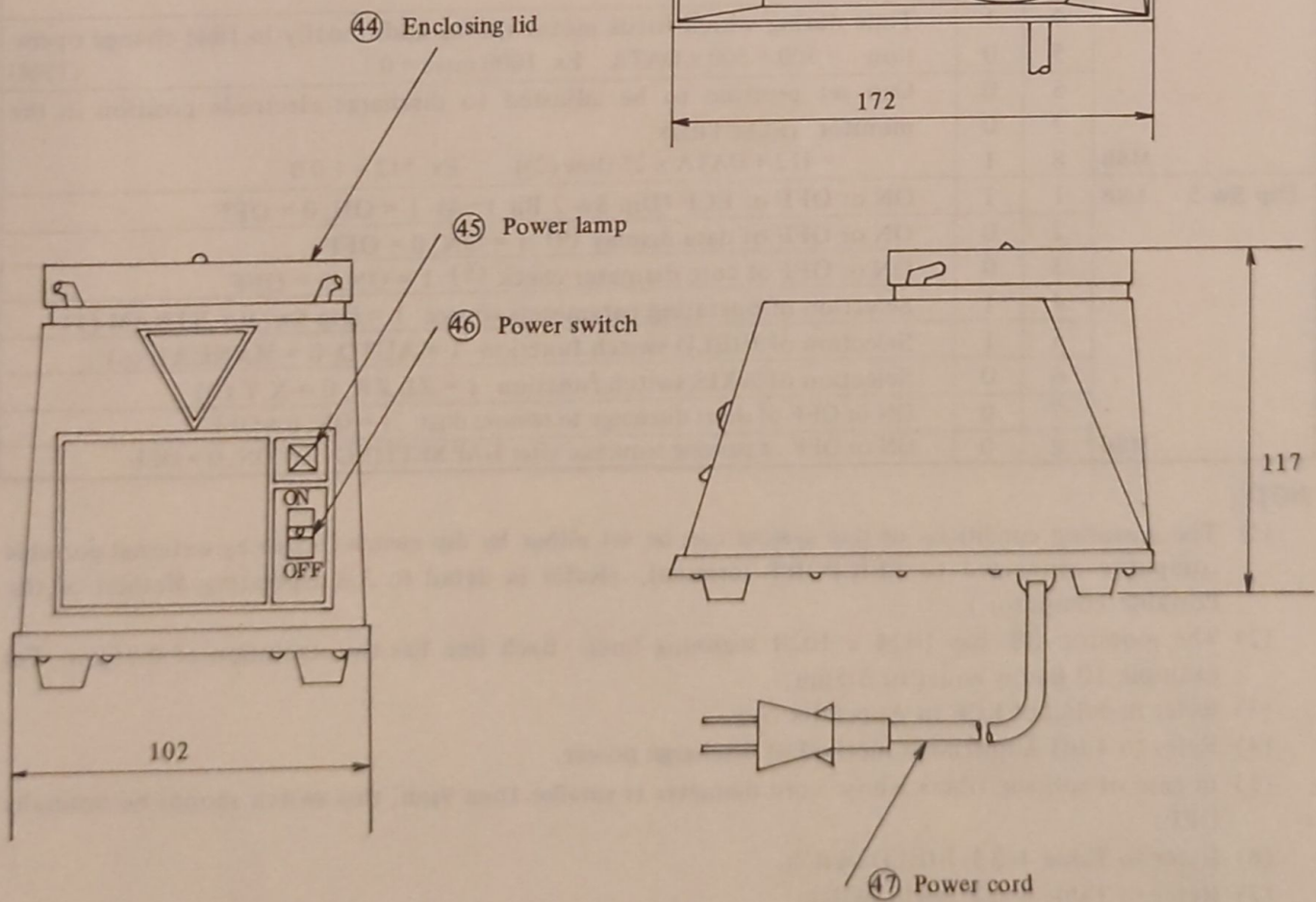


Fig. 6 Ultra-sonic Cleaner

2.2.4 AC power cord

AC power cord has the connector ㊿ to be fixed to the AC power terminal ㉒ at one end and the plug ㊿① for AC power source at the other end. Fig. 7 shows AC power cord.

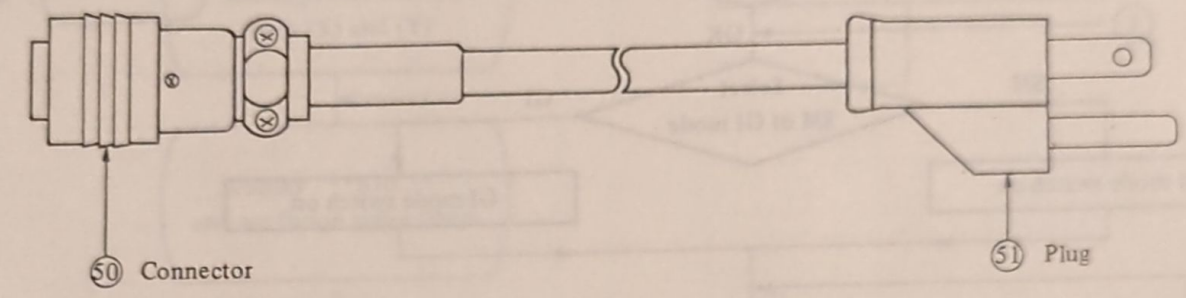


Fig. 7 AC Power Cord

2.2.5 Controlling cable

Controlling cable has connectors ㊿② to be fixed to controlling cable terminal ③ of the splicer main body and of the controller ㉓. Fig. 8 shows the controlling cable.

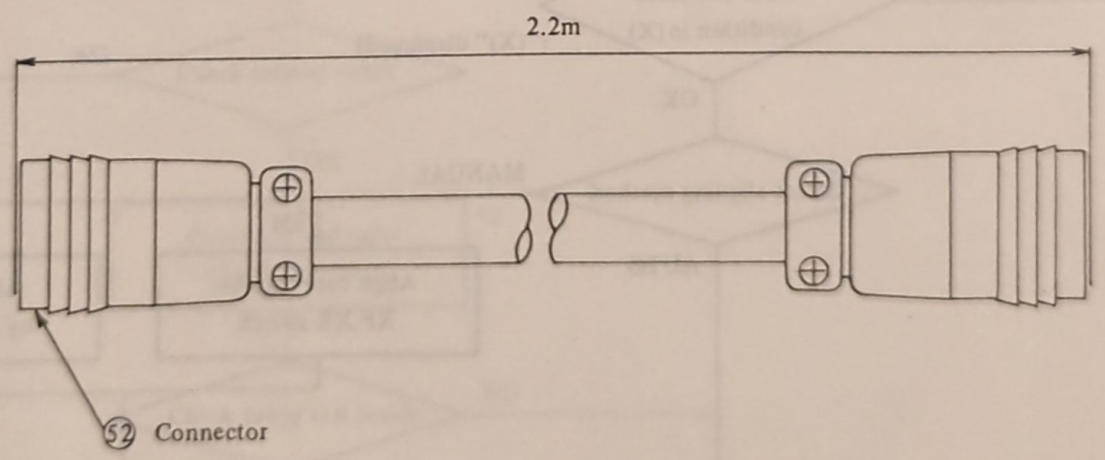
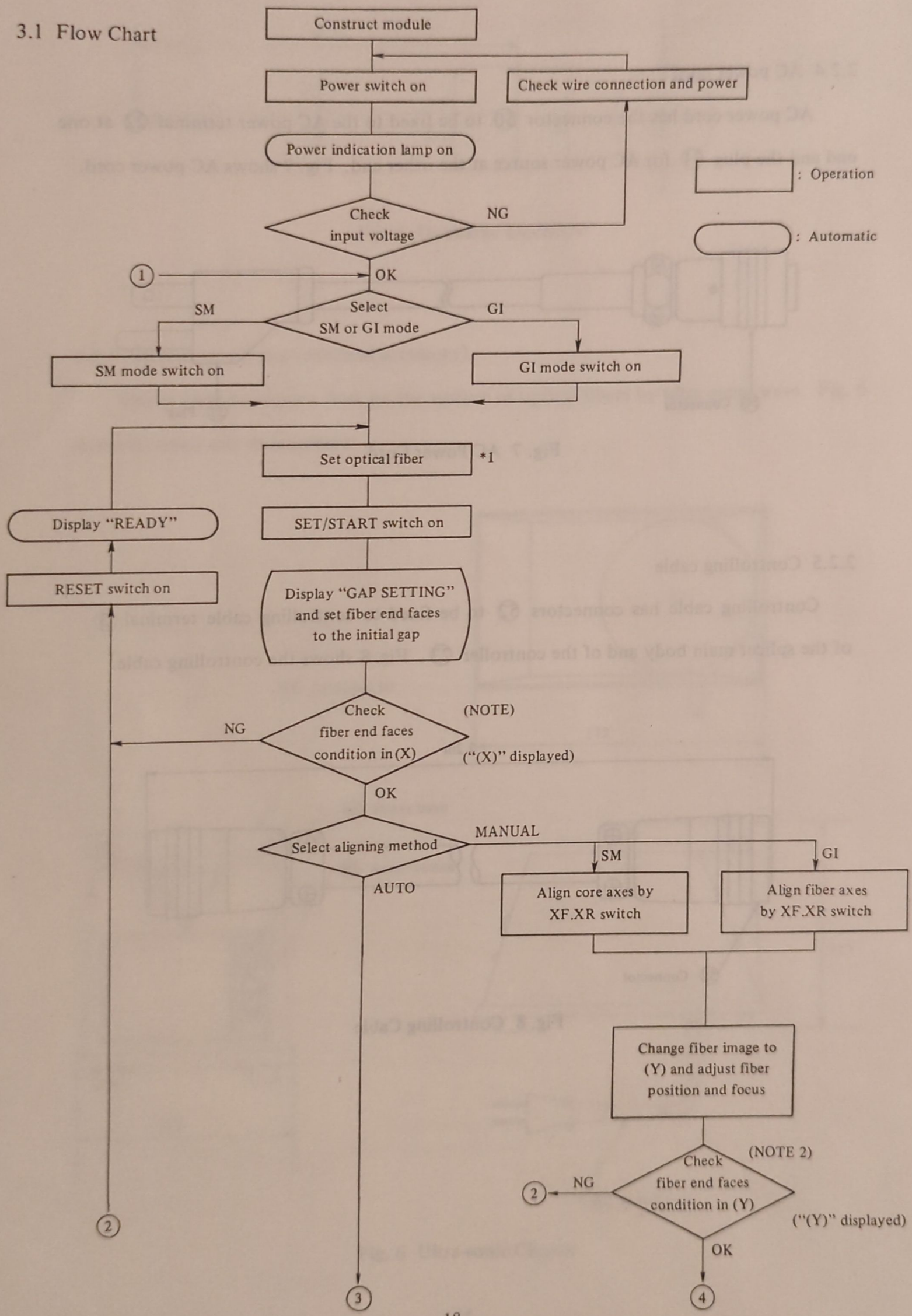
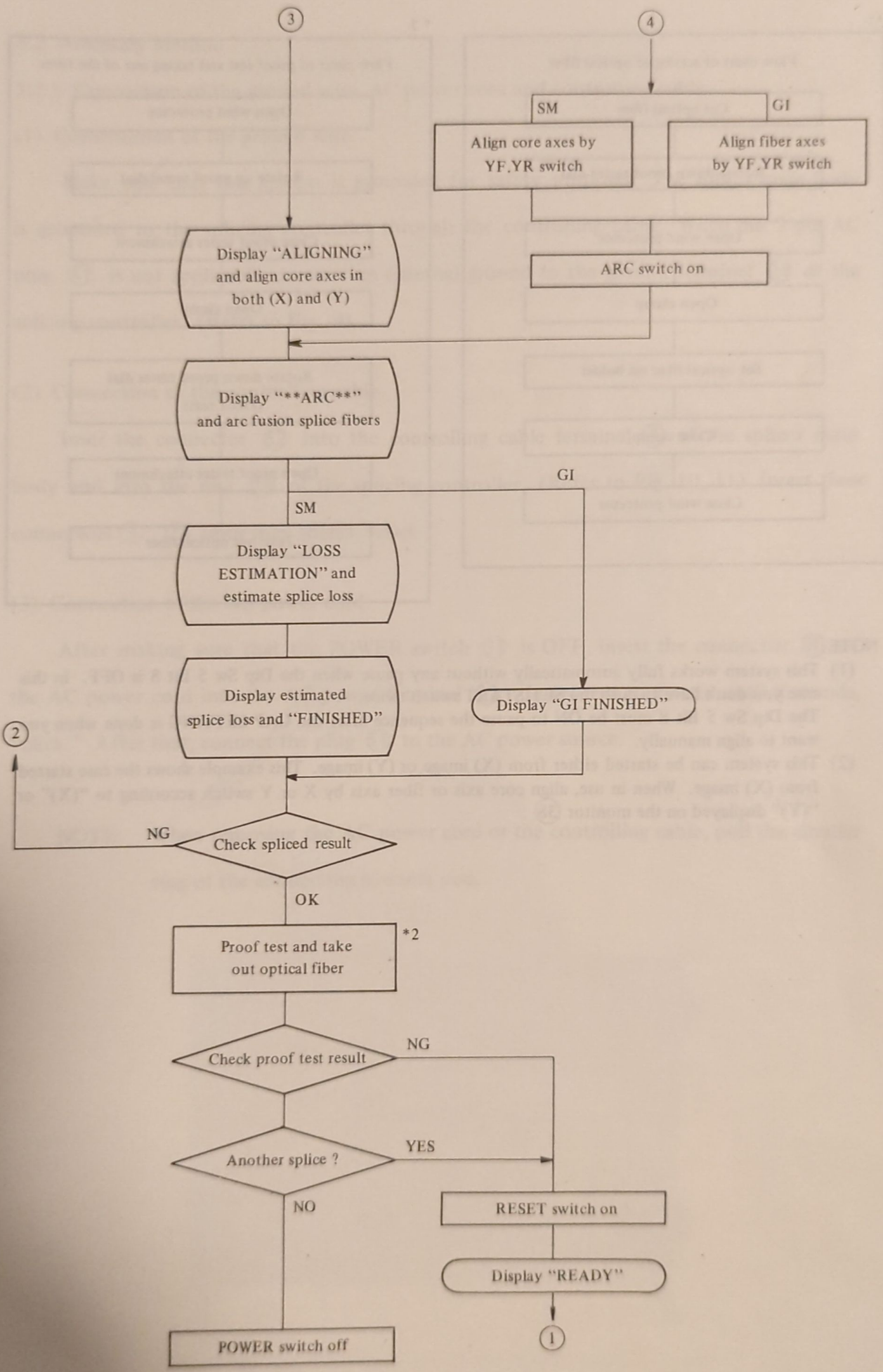


Fig. 8 Controlling Cable

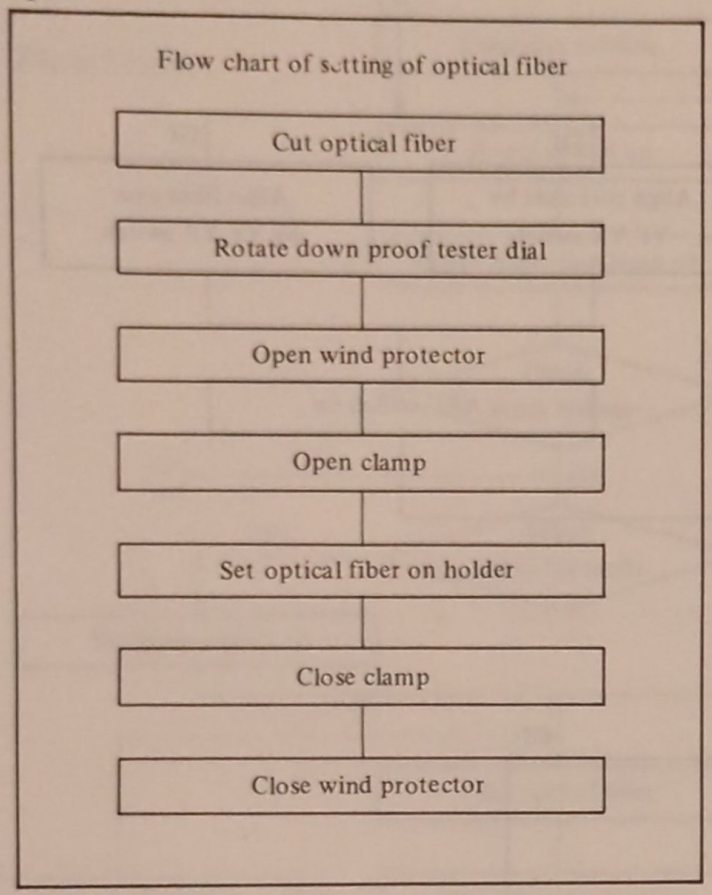
3. OPERATION INSTRUCTIONS

3.1 Flow Chart

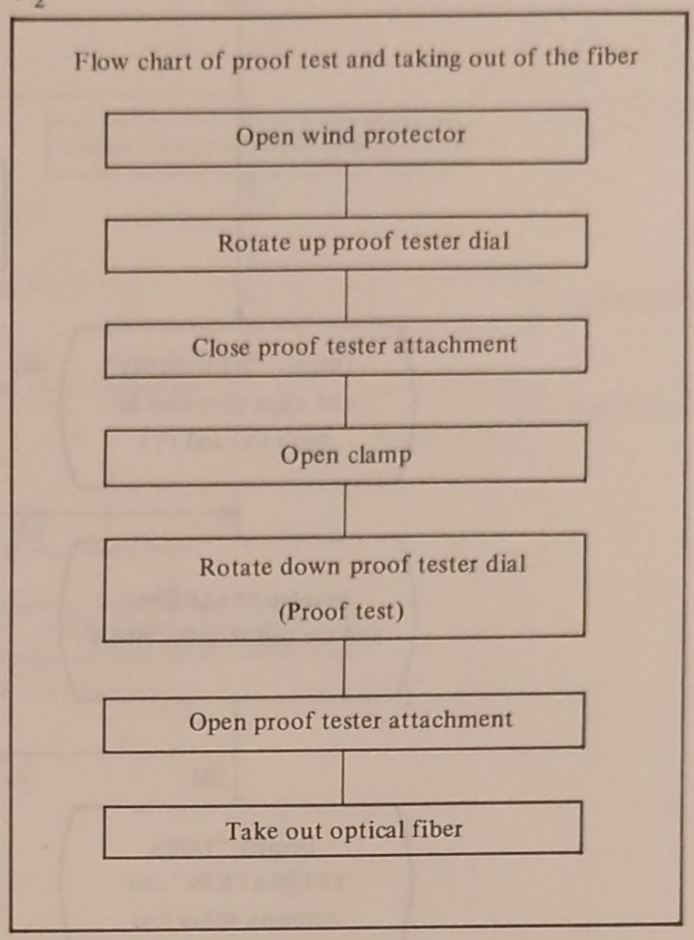



3
4
SM
GI
Align core axes by YF,YR switch
Align fiber axes by YF,YR switch
Display "ALIGNING" and align core axes in both (X) and (Y)
ARC switch on
Display "**ARC**" and arc fusion splice fibers
GI
SM
Display "LOSS ESTIMATION" and estimate splice loss
Display estimated splice loss and "FINISHED"
Display "GI FINISHED"
2
NG
Check spliced result
OK
Proof test and take out optical fiber
*2
Check proof test result
NG
Another splice ?
YES
NO
RESET switch on
Display "READY"
POWER switch off
1

*1



* 2



NOTE:

(1) This system works fully automatically without any pause when the Dip Sw 5 Bit 8 is OFF. In this case you don't have to push the SET/START switch twice.
The Dip Sw 5 Bit 8 must be ON to pause the sequence after the GAP SETTING is done when you want to align manually.

(2) This system can be started either from (X) image or (Y) image. This example shows the case started from (X) image. When in use, align core axis or fiber axis by X or Y switch according to "(X)" or "(Y)" displayed on the monitor (38) .

3.2 Assembly Method

3.2.1 Connection of the ground wire, AC power cord and controlling cable

(1) Construction of the ground wire

Make sure that this system is grounded for safety purposes. The splicer main body is grounded to the splicing controller through the controlling cable. When the 3 pin AC plug ㊶ is not applicable, connect an external ground to the ground terminal ㉔ of the splicing controller. (Refer to Fig. 9)

(2) Connection of the controlling cable

Inser the connector ㊷ into the controlling cable terminal ③ of the splicer main body and into the one ㉓ of the splicing controller. (Refer to Fig. 10, 11) Insert these connectors ③ , ㉓ until they sound, "click."

(3) Connection of the AC power cord

After making sure that the POWER switch ㉛ is OFF, insert the connector ㊵ of the AC power cord into the AC power terminal ㉒ . Insert this connector until it sounds, "click." After that, connect the plug ㊶ to the AC power source.

NOTE: When removing the AC power cord or the controlling cable, pull the circular ring of the connectors towards you.

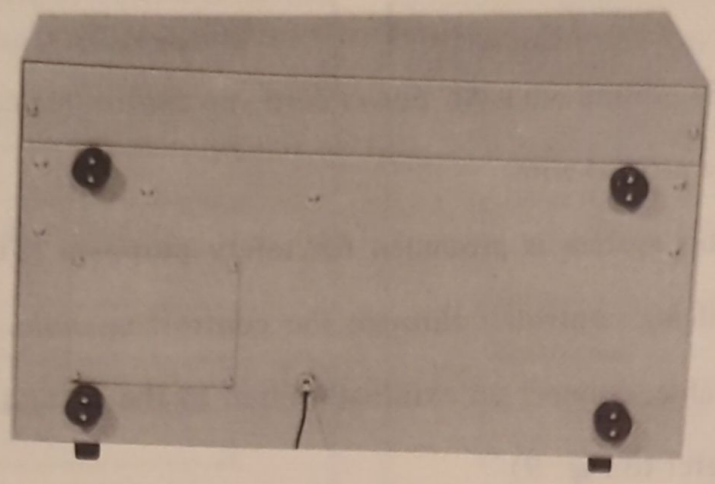


Fig. 9 Connection of the Ground Wire of the Splicing Controller

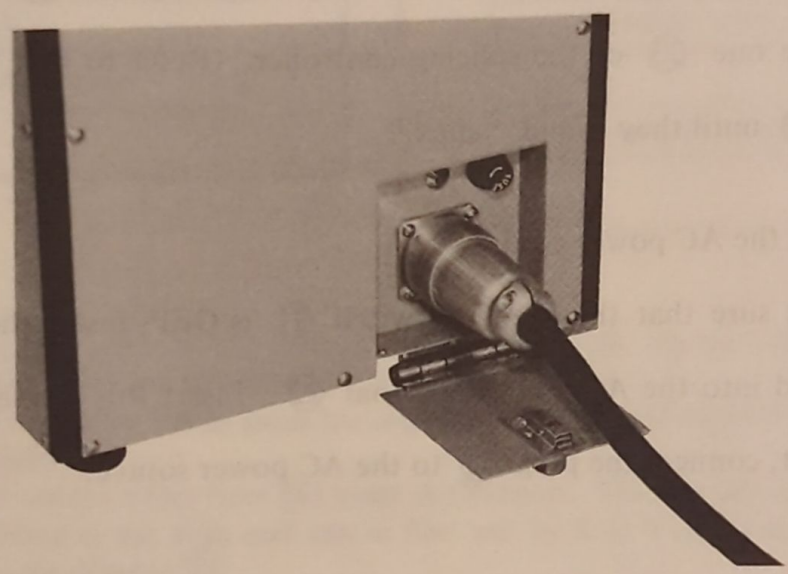


Fig. 10 Connection of the Controlling Cable to the Splicer Main Body

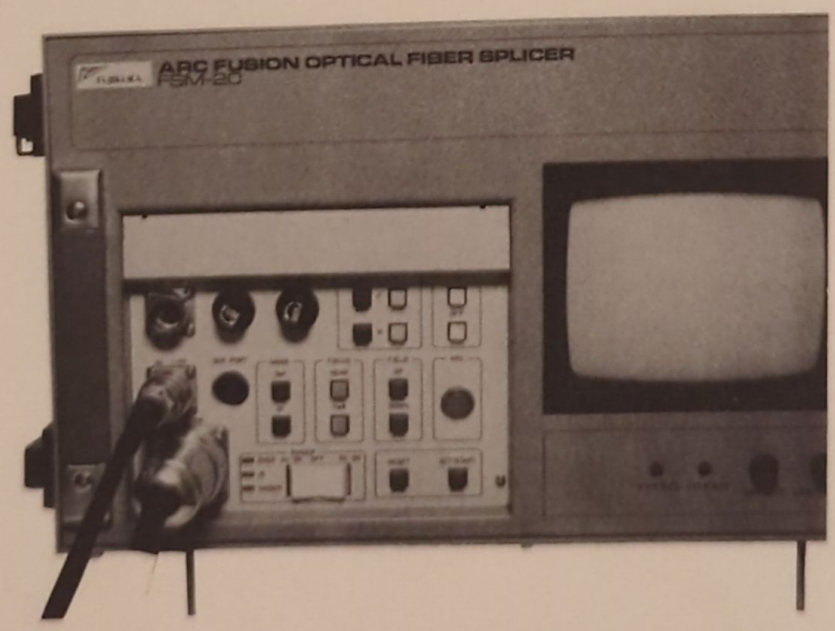


Fig. 11 Connection of the Controlling Cable and AC Power Cord to the Splicing Controller

3.2.2 Setting up the ultra-sonic cleaner (optional accessory)

(1) Insert the power cord (47) of the cleaner to the AC out socket (37) of the splicing controller. When the AC power source is 220 to 240V, be sure to apply the voltage step-down transformer.

(2) Open the enclosing lid and pour water (1 or 2cm height) into the tank.

(3) Pour Ethyl-alcohol of 2–3cm height into the metallic beaker. Then put it into the tank. (Refer to Fig. 12)

NOTE: 1. Confirm that there is some water in the tank of the cleaner before turning on the power switch. If this is not done, then severe damage will occur to the cleaner.

2. Maximum continuous operating time of this cleaner is about half an hour. Therefore, don't operate continuously longer than 30 minutes.

Fig. 12 Setting up the Ultra-sonic Cleaner

3.2.3 Setting up the portable computer

When the portable computer is used (Refer in detail to 3.8), connect the portable computer to the SER. PORT terminal. Refer to Fig. 13.

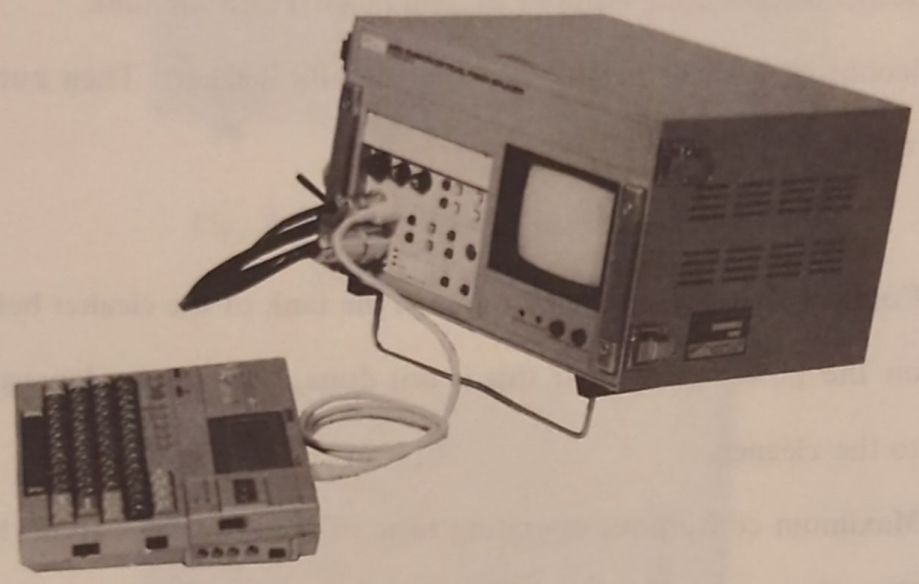


Fig. 13 Connection of the Portable Computer to the Splicing Controller

3.3 Operational Check of Devices

Turn on the POWER switch ㉛ and wait for about 10 seconds. Then make sure that the green lamp of the input voltage indicator ㉙ lights (AC source only) and that "READY". (X)" or "READY (Y)" is displayed on the monitor ㊳.

3.4 Splicing Method of SM Type Optical Fiber

3.4.1 Selection of operation sequence for SM fiber

After confirming "READY" is displayed on the monitor ㊳, depress the SM switch of the MODE switch ㊴ so that the SM switch lights up.

3.4.2 Setting of optical fiber

(1) Cleave the optical fibers to be spliced.

(2) Rotate down the right and left proof tester dials.

(3) Open the wind protrctor ④ and both chuckes of proof tester ⑱. (Refer to Fig. 14)

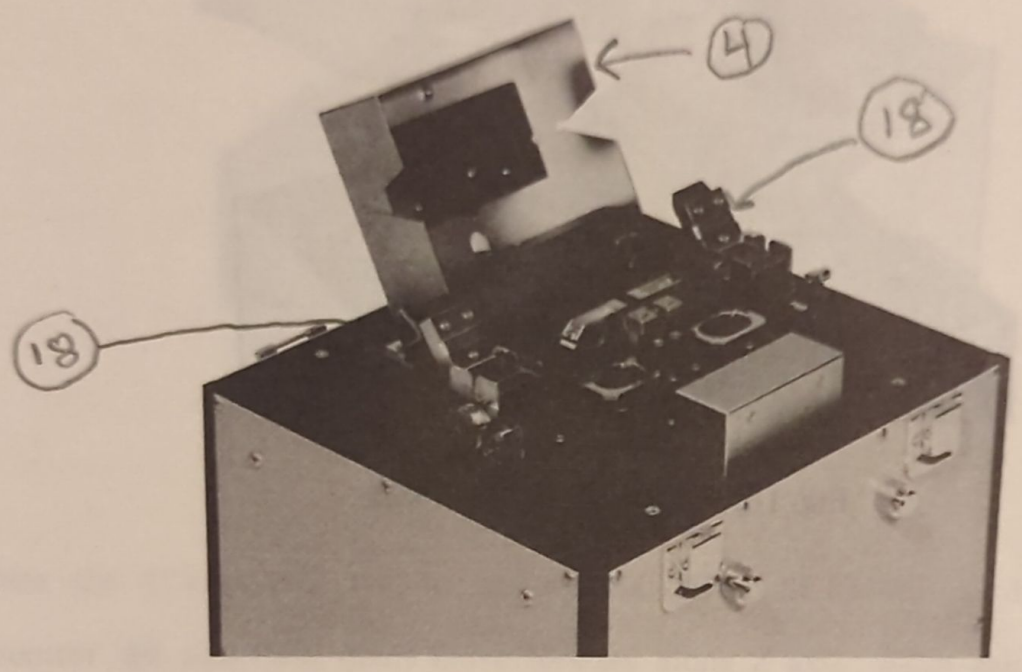


Fig. 14 Opening the Wind Protector

(4) Pull the handle ⑭ toward you, and open the clamp ⑪. (Refer to Fig. 15)

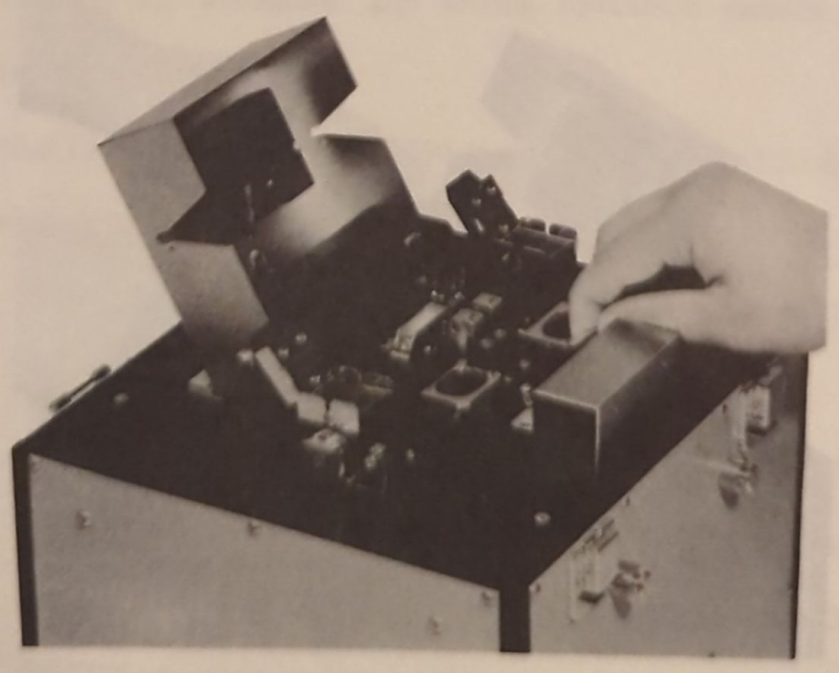


Fig. 15 Opening Clamp

(5) Place the optical fiber on the holder ⑩. (Refer to Fig. 16)

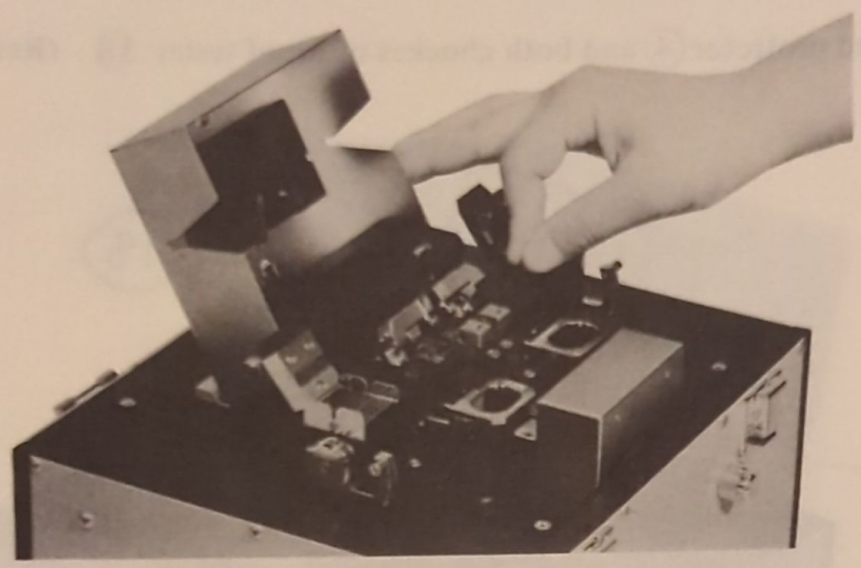


Fig. 16 Setting the Optical Fiber

(6) Carefully push back the handle ⑭ to return it to its home position, and close the clamp ⑪. (Refer to Fig. 17)

Quick return may result in a displacement of the optical fiber from the optical fiber guide unit ⑧.

REPEAT ABOVE STEPS FOR other FIBER TO BE SPLICED

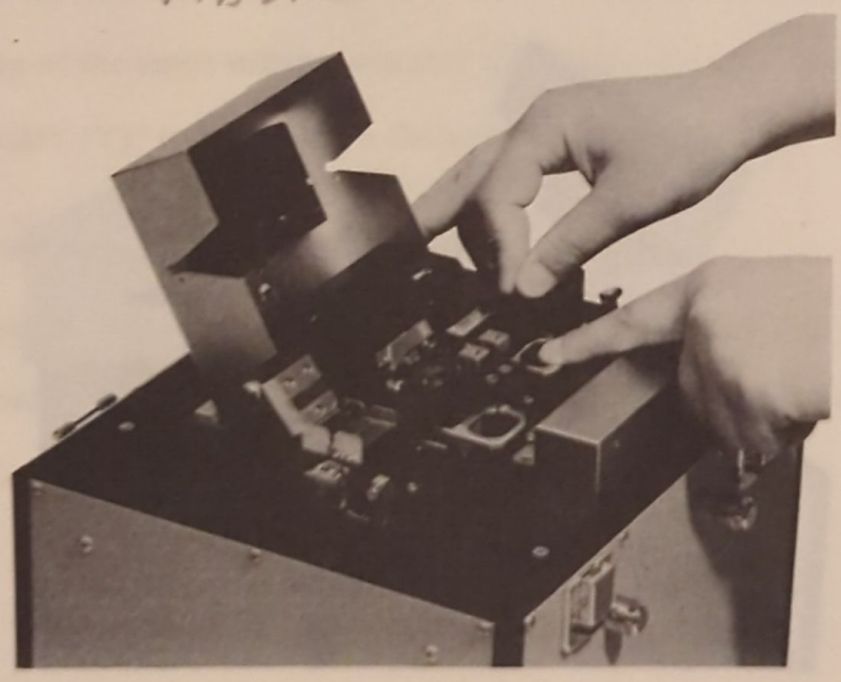


Fig. 17 Closing Clamp

(7) Close the wind protector ④. (Refer to Fig. 18) This activates the illumination lamp light and causes the mirror ⑨ move up.

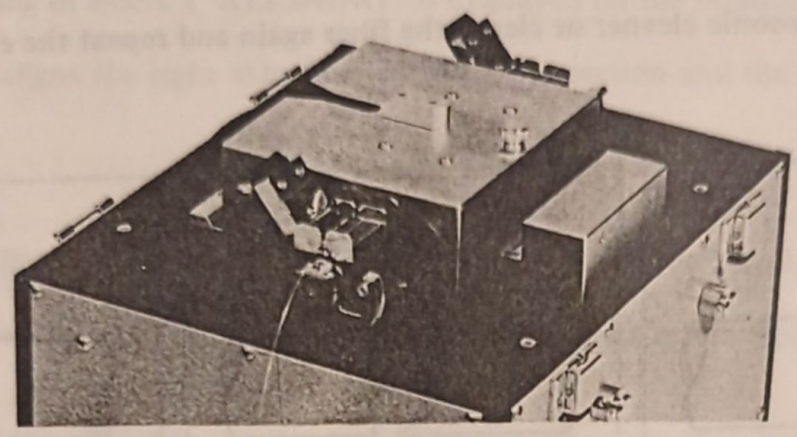


Fig. 18 Closing the Wind Protector

(8) Push the SET/START switch. Afterwards, "GAP SETTING" is displayed on the monitor ㊳ and both fibers move forward along Z axis. After gap setting of both fibers is completed, "CHECK FIBER S/R ?" is displayed on the monitor with beeping sound.

NOTE: Under the largely deviant focus condition caused by manual FOCUS switch operation, the automatic gap setting operation cannot always function normally.

In that case, the FOCUS and FIELD must be recovered to its proper position according to the following steps.

(1) Take out optical fibers from the optical fiber guide unit ⑧ and close the wind protector ④.

(2) Push the SET/START switch to start GAP SETTING operation.

(3) Then OVER RUN ZLF or ZRF must occur and the automatic position returnings of ZL, ZR, FOCUS and FIELD follow. DO NOT PUSH the RESET switch until the position returnings are completed.

3.4.3 Observation on end faces condition in the X (Y) cross section

Check condition of the end faces on the monitor ㊳. If the fibers have substantial dust on their surfaces, or resemble the end faces as shown in Fig. 19, then, clean the fiber using the ultra-sonic cleaner or cleave the fiber again and repeat the entire procedure.

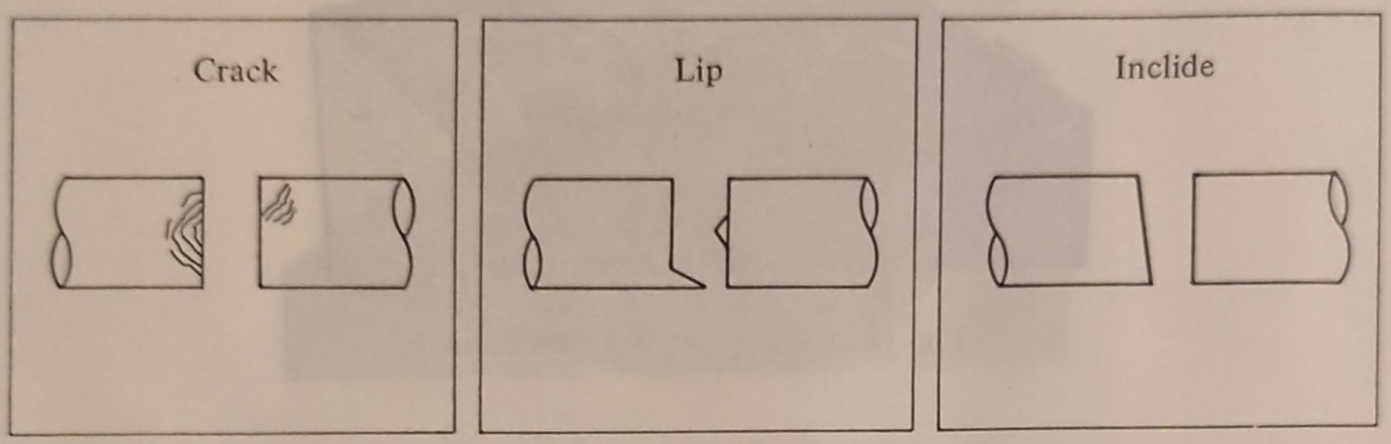


Fig. 19 End View of Optical Fiber

3.4.4 Observation on end faces condition in the Y (X) cross section

Push the SET/START switch again when the PAUSE function (Dip Sw 5 Bit 8) is on. Check fiber end faces condition during automatic aligning operation in the same way as mentioned in 3.4.3.

3.4.5 Automatic splicing

The splicer execute all following operations fully automatically.

(1) Mutual aligning of fibers ("ALIGNING" is displayed on the monitor)

The splicer aligns the right side fiber in (X) cross section and the left side fiber in (Y) cross section.

(2) Arc fusion splicing of fibers ("**ARC**" is displayed on the monitor)

The splicer moves down the mirror ⑨ and splices fibers by arc fusion.

(3) Estimation of the spliced loss ("LOSS ESTIMATION" is displayed on the monitor, and this sequence is only for SM).

The splicer measures the core axis offset by means of image processing and estimates the splice loss. COMPARES THE CORE AXIS ALIGNMENT AFTER THE SPLICE ARC TO THE ALIGNMENT BEFORE THE ARC. READ AT APPROX 20μm EACH SIDE OF SPLICE

(4) Display the estimated loss

The splicer displays the estimated loss (SM only) and "FINISHED" on the monitor ㊳.

3.4.6 Alarm indication

If a certain abnormal operating condition occurs, the splicer displays message on the monitor ㊳ accompanied by about 2 seconds' beep. Those messages are shown in Table 6.

Table 6 Messages Indicating Abnormal Conditions

Messages	Causes	Recommended Steps to Take
OVER RUN XF XR YF YR	There is substantial dust on the optical fiber guide unit ⑧. The fiber is detached from the optical fiber guide unit ⑧. The primary coating of the fiber is not completely removed.	Clean the optical fiber guide unit according to 4.1 MAINTENANCE. Place the fiber again on the optical fiber guide unit. Cut the fiber again and repeat the entire procedure.
OVER RUN FOCUS NEAR FOCUS FAR FIELD UP FIELD DOWN	The fiber is not set properly before start automatic splicing.	The FOCUS and FIELD will recover to its proper position automatically as soon as the OVER RUN occurs. Place the fiber on the fiber guide unit ⑧, then start again from the gap setting. (Refer to 3.4.2 NOTE)
OVER RUN ZLF ZRF	The fiber is cut too short. The fiber is detached from the optical fiber guide unit ⑧.	Cleave the fiber to its proper length.*1 Place the fiber again on the optical fiber guide unit.
OVER RUN ZLR ZRR	During manual operation, the fiber moves back until the limit switch is hit.	The system must recover to the "READY" state as soon as the OVER RUN occurs, so that the system is ready to start.
DATA ERROR	The data transmission is not established between the splicer main body and the splicing controller.	Confirm the controlling cable is connected right to the terminal ③, ㉓.

* 1: The peoper length of the cut fiber is 16±1.0mm for this splicer. This condition can be always satisfied by proper use of the fiber cleaver CT-02 of Fujikura Ltd.

When ERROR 1 ~ 6 occur, check which is the cause among those messages displayed on the monitor. Then push the RESET switch and take the recommended step in the right column.

Messages	Recommended Steps to Take
ERROR 1 GAP IS NOT SET CORRECTLY RESET AND TRY AGAIN	Place the optical fibers on V grooves again and push the SET/START switch.
ERROR 2 F18ER IS SET WRONG OR DUSTY MIRROR/LENS OR ELECTRODE IMAGE IS ON THE MONITOR	*1 · Cleave the optical fibers again to proper length. · Clean the mirrors and objective lens. · Turn off the Dip Sw 5 Bit 5 to make te FIELD switch function manual. Push one of FIELD switches until the electrode image as shown in Fig. 362-5 (P36-14) disappears from the monitor. Then take the steps mentioned in NOTE on P27.
ERROR 3 WIND PROTECTOR IS OPENED OR LAMP IS DARK OR DUSTY MIRROR/LENS	· Close the wind protector and push the SET/START switch. · Consult the manufacturer. · Clean the mirrors and objective lens.
ERROR 4 FIBER IMAGE IS NOT ON THE MONITOR	· This error occurs when the automatic FIELD exchange operation does not work well. Follow the steps on P36-10.

continued to next page

continued from previous page

Messages	Recommended Steps to Take
ERROR 5 DUSTY FIBER SURFACE OR WRONG ANGLE OF THE MIRROR INSIDE THE WIND PROTECTOR	· Remove the coating of the fibers and clean the fiber surface thoroughly and cleave them again. · Consult the manufacturer.
ERROR 6 FIBER IMAGE CAN'T BE EXCHANGED → TURN ON DIP SW4 BIT 1 ~ 3 OR FASTEN FIELD MOTOR SPEED	· This error occurs when the automatic FIELD exchange operation does not work well. Follow the steps on P36-10. Consult the manufacturer when the splicer cannot be recovered by the dip switch operation.

3.4.7 Manual alignment

At the point of checking the fiber end faces condition, alignment can be done manually. Push the XF(YF). XR(YR) switch to align the core axes so that the fiber image is the same as illustrated in Fig. 20.

But accurate core alignment can not be done in the case when out of focus. Because the core axes position on the monitor is significantly different from the real one. This case is obvious especially when the fibers have large eccentricity.

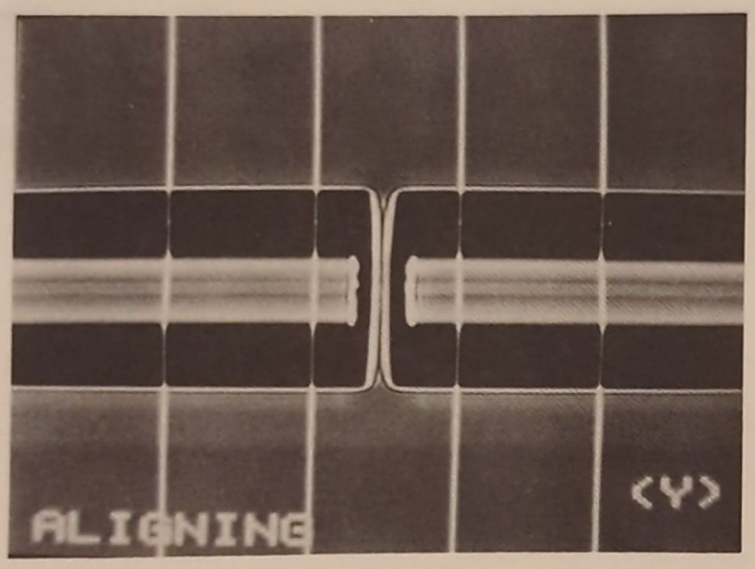


Fig. 20 Aligned SM Fiber Image on the Monitor

3.4.8 Observation on spliced results

(1) After fusion splicing, if bubbles such as in Fig. 21 are seen on the monitor ㊳, the steps described in Table 7 should be taken.

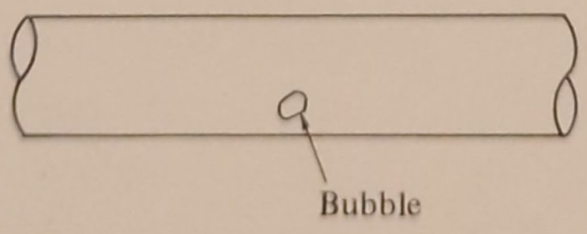


Fig. 21 Appearance of Bubble

(2) If the spliced result is like the kind depicted in Fig. 22, the steps described in Table 7 should be taken.

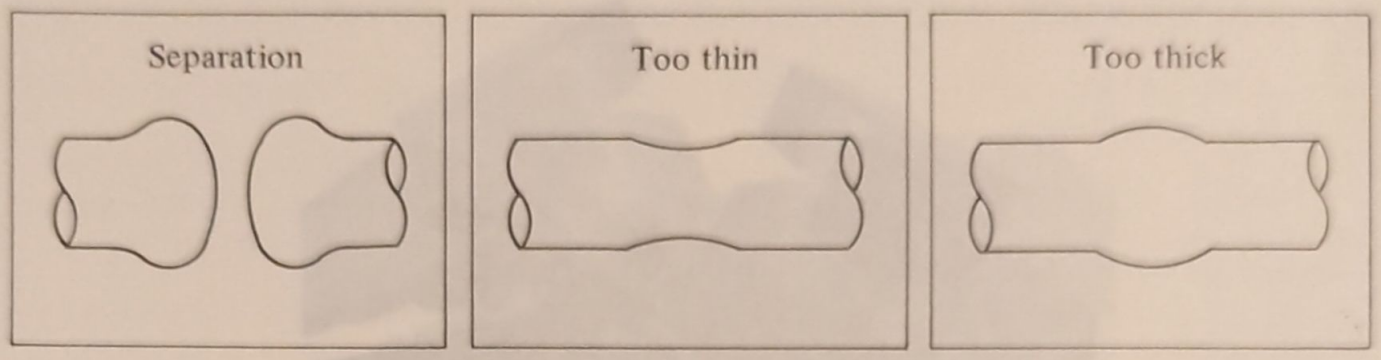


Fig. 22 Defective Spliced Results

Table 7 Treatment of Defective Spliced Results

Defective Results	Cause	Recommended Steps to Take
○ Appearance of bubble	○ Improper cleaving of optical fiber ○ Dust on fiber end faces	Cleave the fiber again or change the fiber cutter.
○ Becomes too thin	○ Abnormal discharge ○ Malfunction of fusion splicer main body	Adjust the splice condition
○ Becomes to thick	○ Malfunction of fusion splicer main body	Adjust the splice condition

3.4.9 Removing the optical fiber

(1) Open the wind protector ④ and rotate up the right and left proof tester dials ⑮. (Refer to Fig. 23)

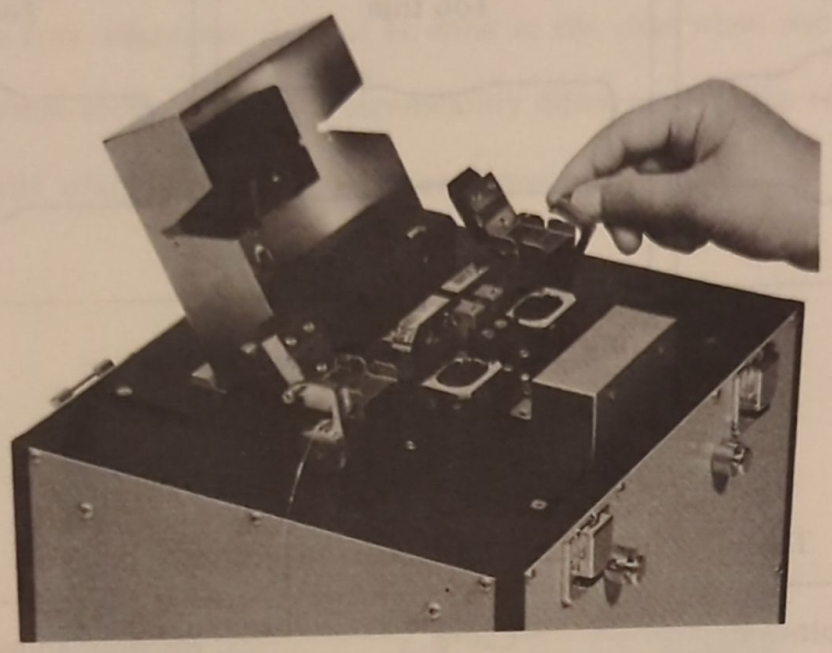


Fig. 23 Opening the Wind Protector and Rotation of Operation Dials

(2) Close the fiber chucks of the proof tester attachment ⑱ until "click" sound. Then slowly pull the handle ⑭ toward you. (Refer to Fig. 24)

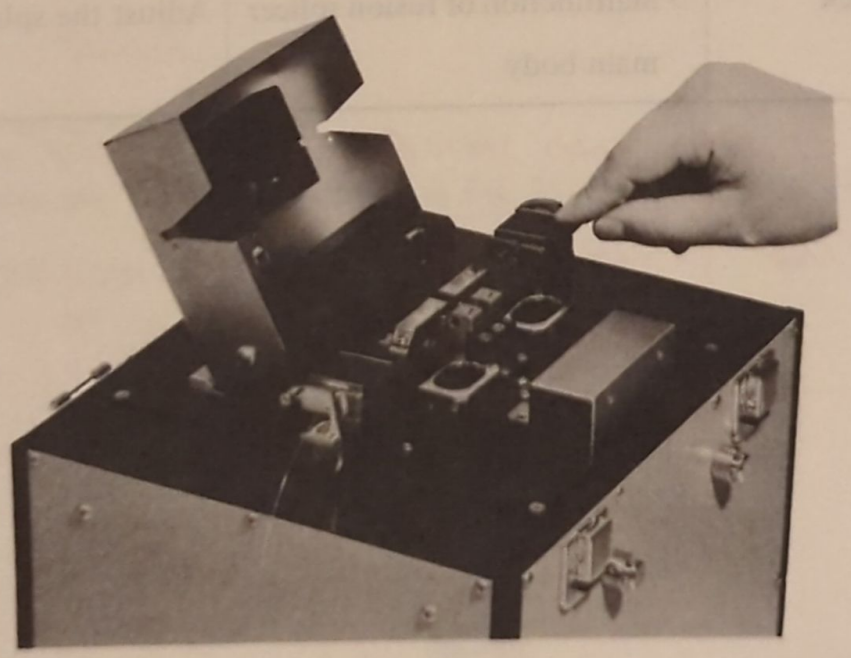


Fig. 24 Closing the Fiber Chucks of the Proof Tester Attachment

(3) Slowly rotate the right and left proof tester dials ⑮ toward you. (Refer to Fig. 25) If you do this, screening test is applied on the optical fiber spliced portion.

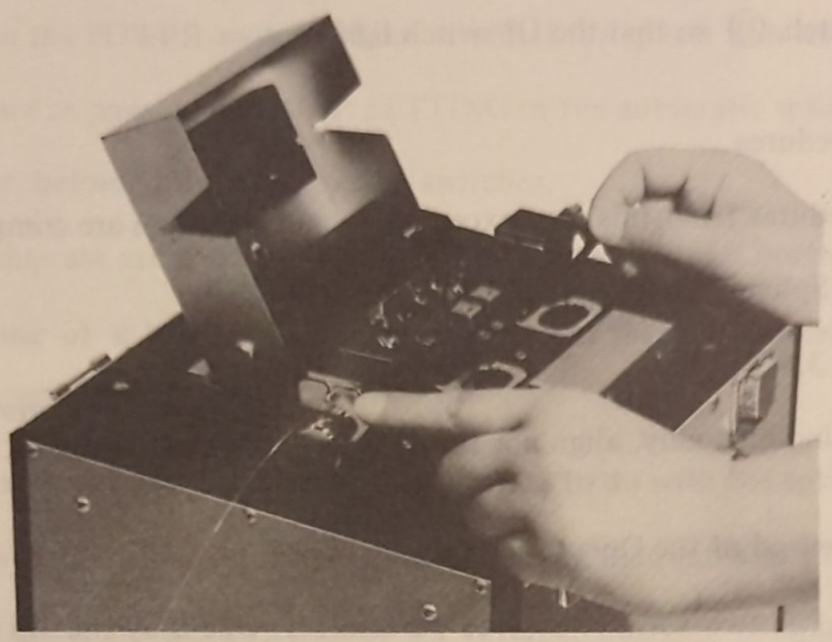


Fig. 25 Rotation of Proof Tester Dials

(4) Open the fiber chucks of the proof tester attachment ⑱. Then remove the optical fiber from the holder ⑩. (Refer to Fig. 26)

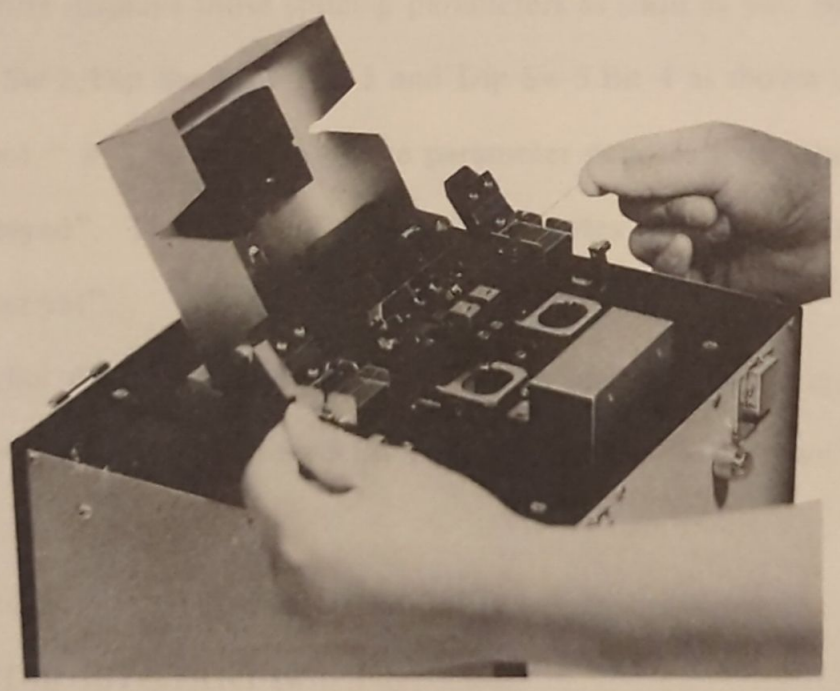


Fig. 26 Removing the Optical Fiber

(5) Depress the RESET switch ㉞ and make sure "READY" is displayed on the monitor ㊳.

3.5 Splicing Method of GI Type Optical Fiber

3.5.1 Selection of operation sequence for GI fiber

After confirming "READY" is displayed on the monitor ㊳, depress the GI switch of the MODE switch ㊴ so that the GI switch lights up.

3.5.2 Other procedures

Other procedures from this step except for loss estimation are completely the same as described in 3.4 Splicing Method of SM Type Optical Fiber.

Refer to sections 3.4.2 ~ 3.4.9.

But in aligning manually, align not the core axes but the fiber axes.

3.6 Replacing Method of the Operation Parameters

This system has two ways to replace parameters. One is by the dip switches ㊸ and the other is by external computer. When using dip switches, replace parameters according to the following sections. In using the external computer, refer to Section 3.8.

3.6.1 How to replace the operating parameters

The functions stated below are added from the program version of "DOM16". The program version is displayed on the monitor for about 1 second as shown in Fig. 361-0 just after you turned on the POWER switch. Make sure that the splicer is in its READY state or the splicing sequence is paused after GAP SETTING or the automatic splicing sequence has completely finished, before you handle the dip switches.

The dip switches are arranged on the controller operating panel horizontally, and each dip switch consisting of 8 bits (switches) is named from the extreme left as Dip Sw 1 ~ Dip Sw 5 respectively.

The parameters that have directly important things to do with the splice result are gap, prefusion time, discharge time, discharge power, stuffing amount and ECF. These parameters can be set either by dip switches or by external portable computer. The splicer selects parameters either from dip switches or from BTRAM (parameters decided by external computer) depending on whether the Dip Sw 5 Bit 4 is ON or OFF. The splicing controller displays for 0.5 second which parameter source the controller uses as shown in Fig. 361-1 just after you turned on the POWER switch.

The controller displays those splicing parameters as soon as you changed even one bit of Dip Sw 1 ~ Sw 2, Dip Sw 3 Bit 1 ~ 5 and Dip Sw 5 Bit 4 as shown in Fig. 361-2 (A) or (B). The symbol " # " on the left of the parameter denotes that "the parameter is now changed as displayed". The symbol " * " in (B) denotes that "the parameter is not set by external computer yet".

The controller displays the other parameters as soon as you changed even one bit of Dip Sw 3 Bit 6 ~ 8, Dip Sw 4, Dip Sw 5 Bit 1 ~ 3 and Bit 5 ~ 8 as shown in Fig. 361-2 (C) ~ (M).

All the abbreviations are detailed in 3.6.2. The controller clears the parameters' display when the RESET or SET/START switch is pushed.

Check that parameters displayed is exactly what you need and that the symbol " * " is not displayed unless otherwise unpredictably strange operation must occur.

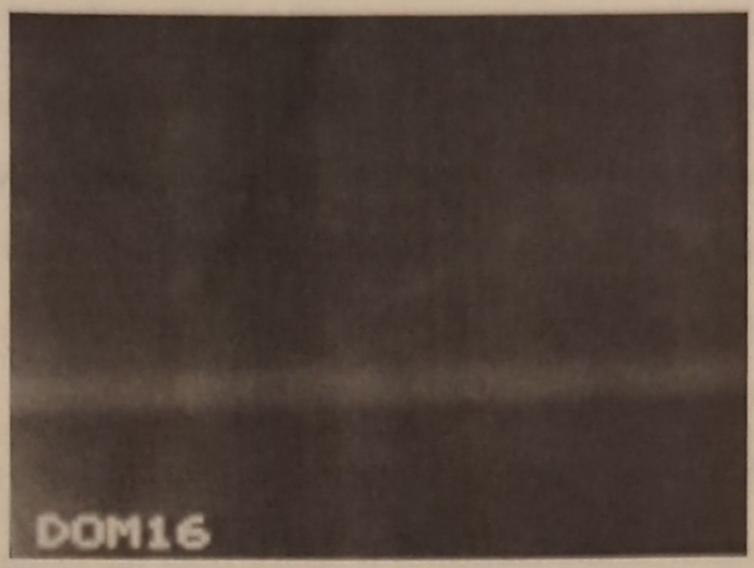
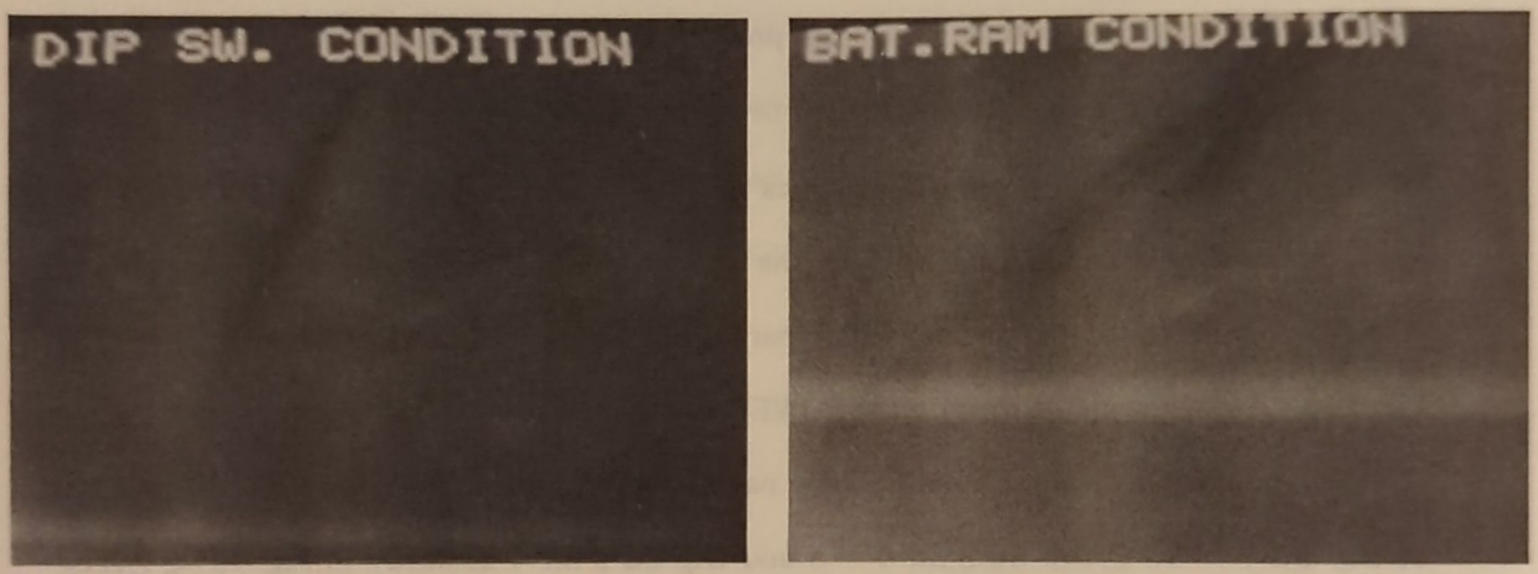
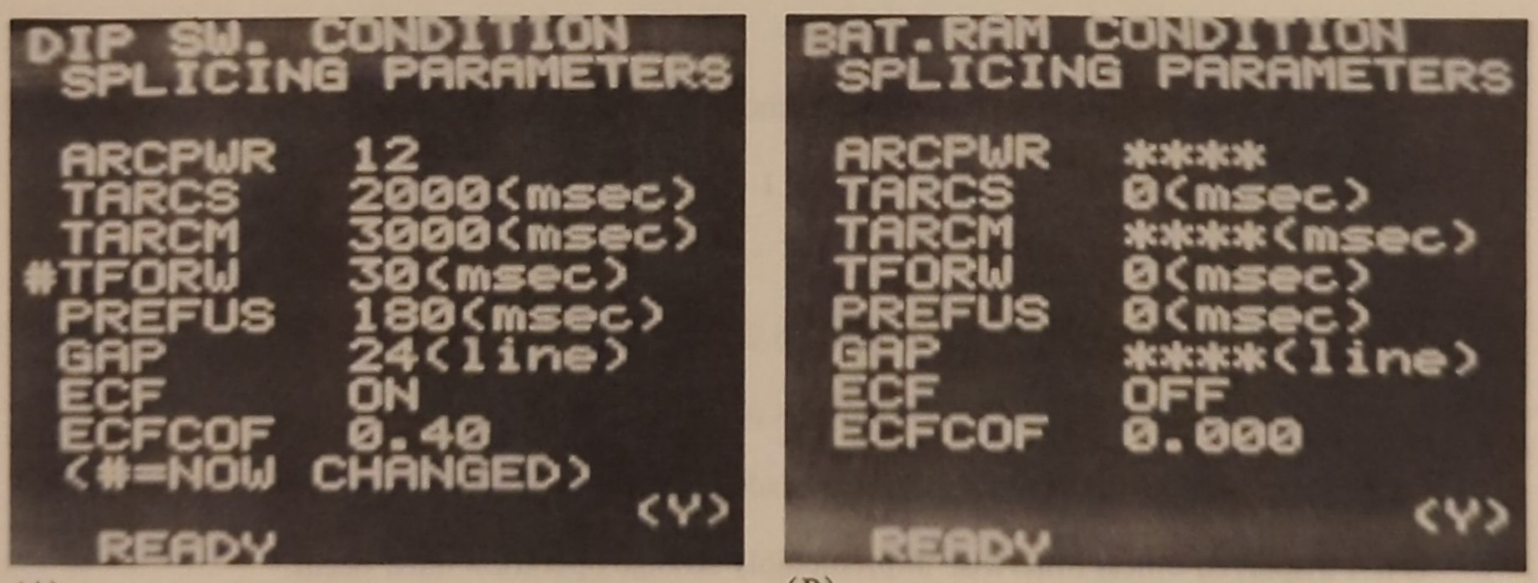


Fig. 361-0 Display of Program Version on the Monitor



(A) (B)

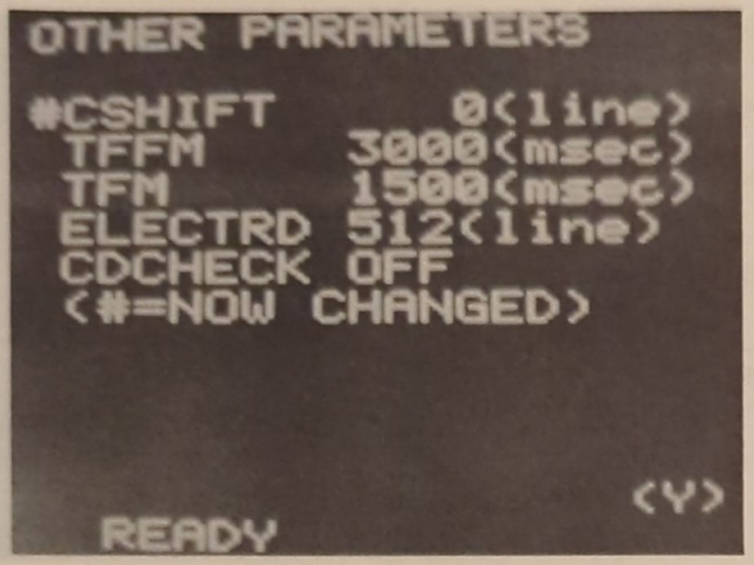
Fig. 361-1 Parameter Source Display by the Splicing Controller



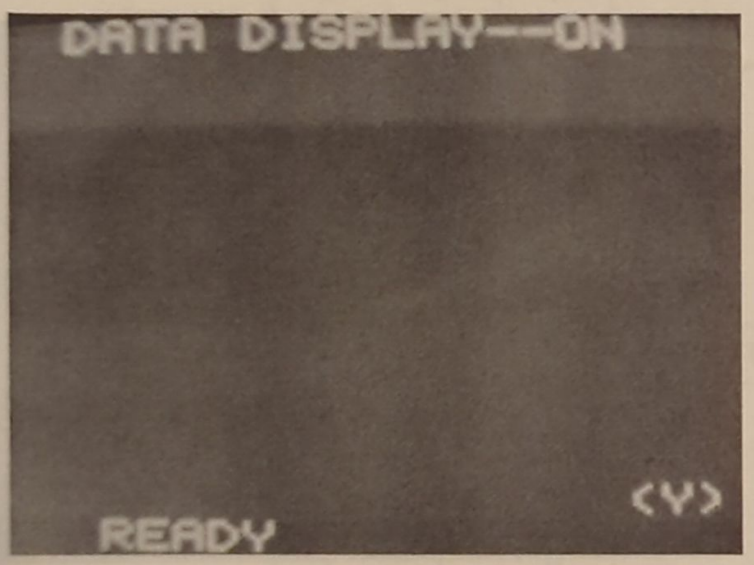
(A) (B)

Fig. 361-2 Examples of Parameter Displays by the Splicing Controller

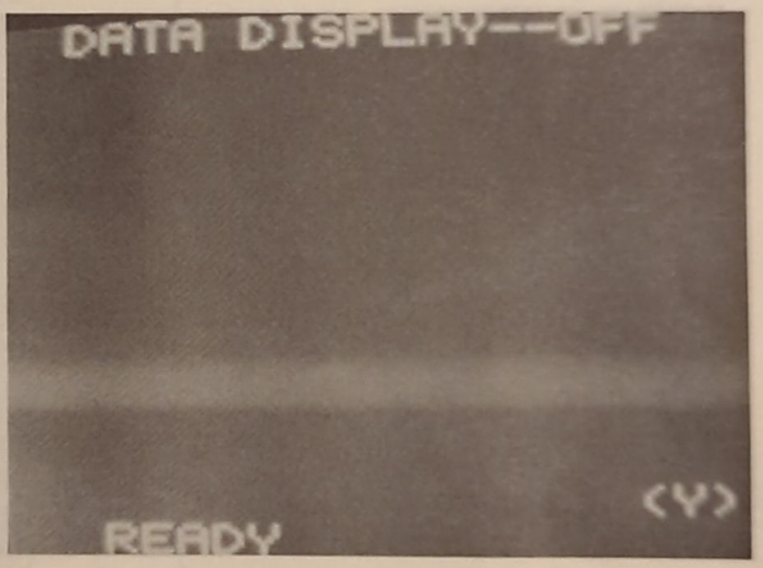
TO GET DIP SW DISPLAY - TO GOOD
A DIP SWITCH ON + OFF, PREFERABLY
DIP SW 3 BIT 1. (IF ON, GO OFF + ON)



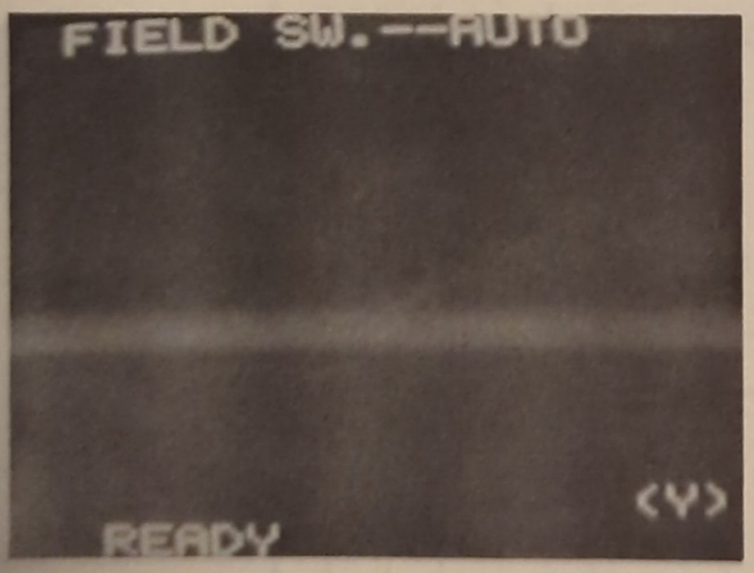
(C)



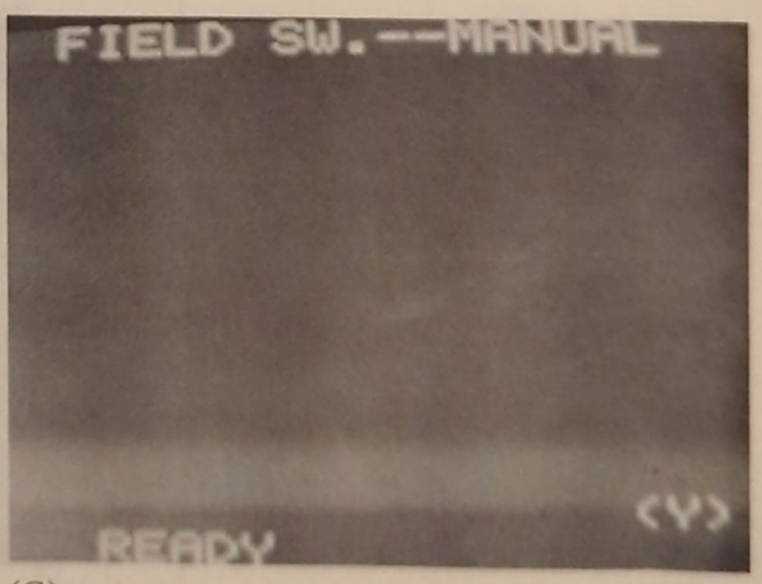
(D)



(E)

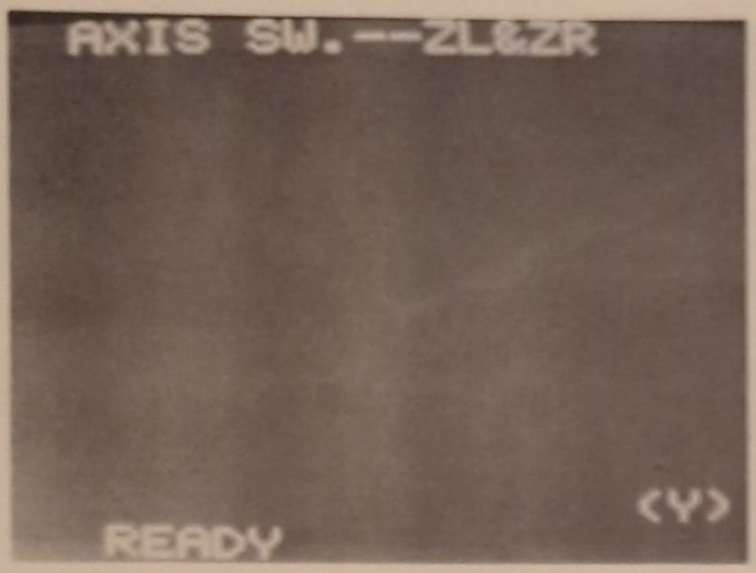


(F)

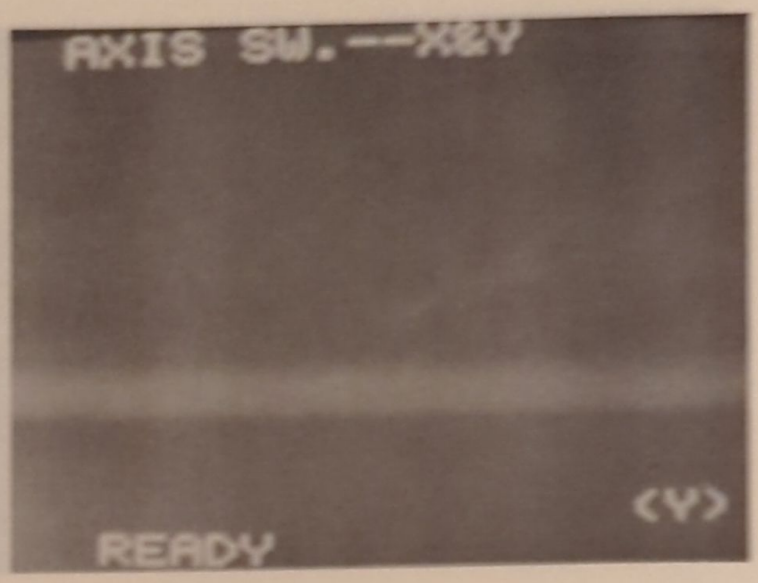


(G)

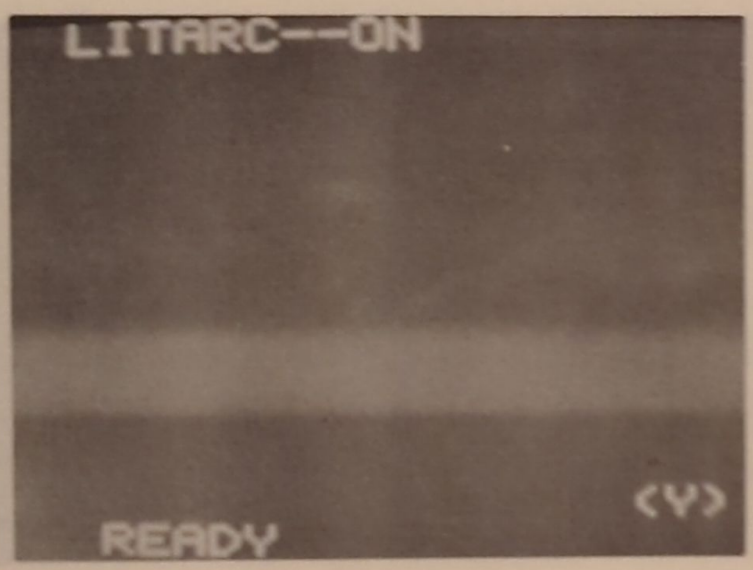
Fig. 361-2 Examples of Parameter Displays by the Splicing Controller



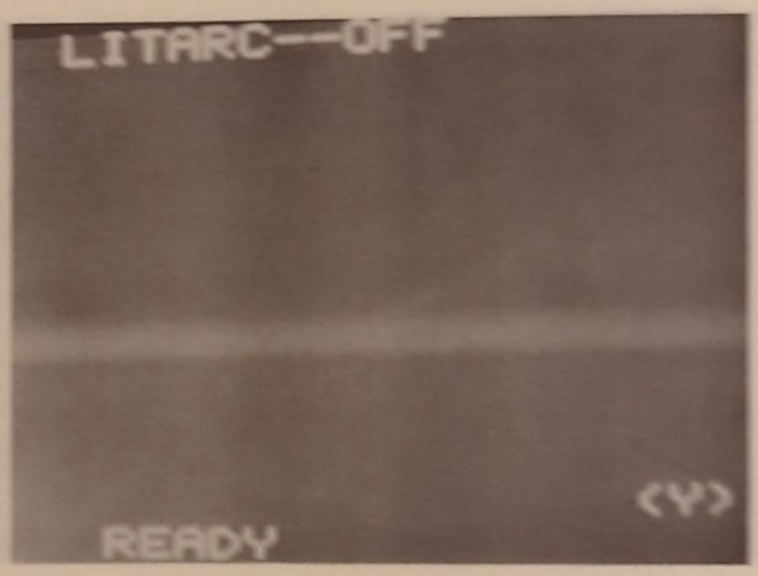
(H)



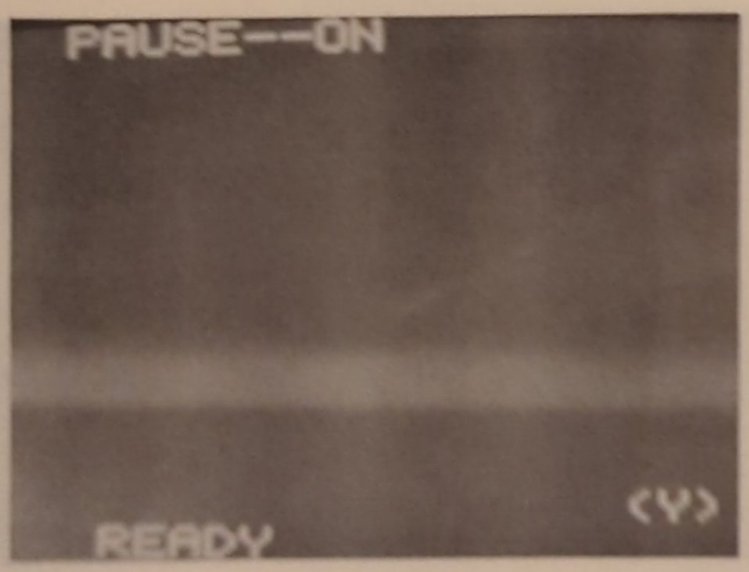
(I)



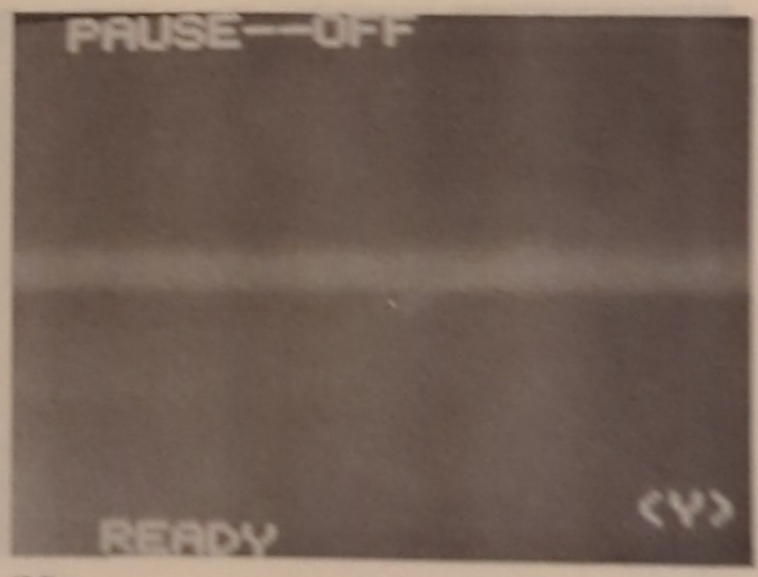
(J)



(K)



(L)



(M)

Fig. 361-2 Examples of Parameter Displays by the Splicing Controller

3.6.2 Review of each dip switch function

(1) Time during which the fiber moves foward along Z-axis during discharge, TFORW (Stuffing amount) (only left fiber moves)

Dip Sw 1 Bit 1 ~ 3

0 - Down
1 - up

Bit 1	Bit 2	Bit 3	TFORW (msec)
0	0	0	10
1	0	0	15
0	1	0	20
1	1	0	25 ✓
0	0	1	30
1	0	1	35
0	1	1	40
1	1	1	45

25

(2) Prefusion time at splicing, PREFUS

Dip Sw 1 Bit 4 ~ 6

Bit 4	Bit 5	Bit 6	PREFUS (msec)
0	0	0	100
1	0	0	120
0	1	0	140
1	1	0	160
0	0	1	180 ✓
1	0	1	200
0	1	1	220
1	1	1	240

180

(3) Initial gap of fiber end faces, GAP

Dip Sw 1 Bit 7 ~ 8

Bit 7	Bit 8	GAP (line)	GAP (μm)
0	0	8	2.8
1	0	16	5.6
0	1	24 ✓	8.4
1	1	32	11.2

24

YELLOW - FACTORY RECOMMENDATION
✓ - CURRENT SETTINGS

(4) Coefficient of Eccentricity Correct Function (ECFCOF)

The definition of ECFCOF is given on P52. The distance to be shifted intentionally after aligned can be increased or decreased by increasing or decreasing the ECFCOF.

Dip Sw 2 Bit 1 ~ 4

Bit 1	Bit 2	Bit 3	Bit 4	ECFCOF
0	0	0	0	0
1	0	0	0	0.05
0	1	0	0	0.10
1	1	0	0	0.15
0	0	1	0	0.20
1	0	1	0	0.25
0	1	1	0	0.30
1	1	1	0	0.35
0	0	0	1	0.40
1	0	0	1	0.45
0	1	0	1	0.50
1	1	0	1	0.55
0	0	1	1	0.60
1	0	1	1	0.65
0	1	1	1	0.70
1	1	1	1	0.75

40

(5) Discharge time in SM (Single Mode) splicing mode, TARCS

Dip Sw 2 Bit 5 ~ 6

Bit 5	Bit 6	TARCS (msec)
0	0	1000
1	0	1500
0	1	2000
1	1	2500

2500

(6) Discharge time in GI (Graded Index or Multi Mode) splicing mode, TARCM.

Dip Sw 2 Bit 7 ~ 8

Bit 7	Bit 8	TARCM (msec)
0	0	3000
1	0	4000
0	1	5000
1	1	6000

(7) Discharge Power, ARCPWR

Dip Sw 3 Bit 1 ~ 5

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	ARCPWR	ARCPWR (mA)
0	0	0	0	0	0	12
1	0	0	0	0	1	12.3
0	1	0	0	0	2	12.6
1	1	0	0	0	3	12.9
0	0	1	0	0	4	13.2
1	0	1	0	0	5	13.5
0	1	1	0	0	6	13.8
1	1	1	0	0	7	14.1
0	0	0	1	0	8	14.4
1	0	0	1	0	9	14.7
0	1	0	1	0	10	15.0
1	1	0	1	0	11	15.3
0	0	1	1	0	12	15.6
1	0	1	1	0	13	15.9
0	1	1	1	0	14	16.2
1	1	1	1	0	15	16.5
0	0	0	0	1	16	16.8
1	0	0	0	1	17	17.1
0	1	0	0	1	18	17.4
1	1	0	0	1	19	17.7
0	0	1	0	1	20	18.0
1	0	1	0	1	21	18.3
0	1	1	0	1	22	18.6
1	1	1	0	1	23	18.9
0	0	0	1	1	24	19.2
1	0	0	1	1	25	19.5

continued to next page

INCREASE ARCPWR 1 STEP PER ADDITIONAL 500' ABOVE SEA LEVEL FOR BEST RESULTS.

continued from previous page

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	ARCPWR	ARCPWR(mA)
0	1	0	1	1	26	19.8
1	1	0	1	1	27	20.1
0	0	1	1	1	28	20.4
1	0	1	1	1	29	20.7
0	1	1	1	1	30	21.0
1	1	1	1	1	31	21.3

The discharge current is roughly approximated value.

Therefore the controller displays the ARCPWR using dimensionless numerals 0 ~ 31.

(8) Amount of gap set position shift in (Y) image based on (X) image, CSHIFT.

Dip Sw 3 Bit 6 ~ 8

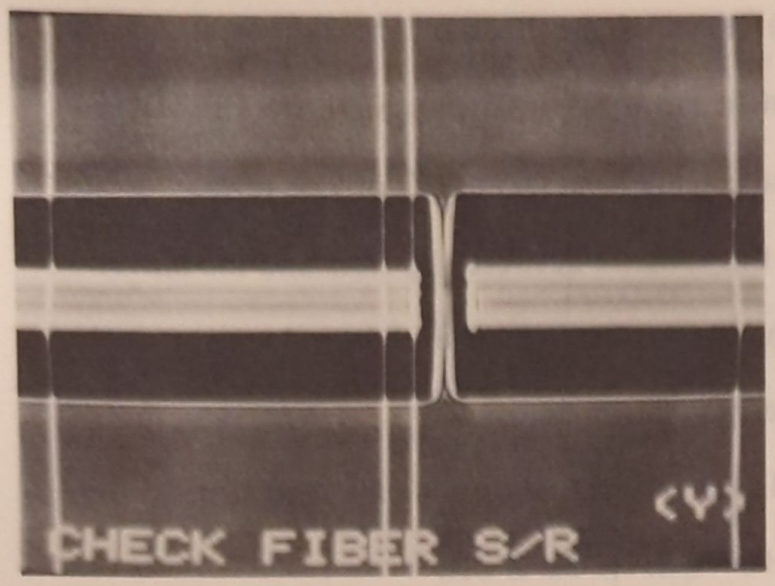
Bit 6	Bit 7	Bit 8	CSHIFT (line)	CSHIFT (μm)	CASE
0	0	0	0	0	(A) ✓
1	0	0	+10	+3.5	
0	1	0	+20	+7.0	(B)
1	1	0	+30	+10.5	
0	0	1	0	0	(A)
1	0	1	−10	−3.5	
0	1	1	−20	−7.0	(C)
1	1	1	−30	−10.5	

The position of set gap may shift right or left as illustrated in Fig. 362-1 (B) or (C) respectively when the FIELD is moved from (X) to (Y). Use these dip switches in this case.

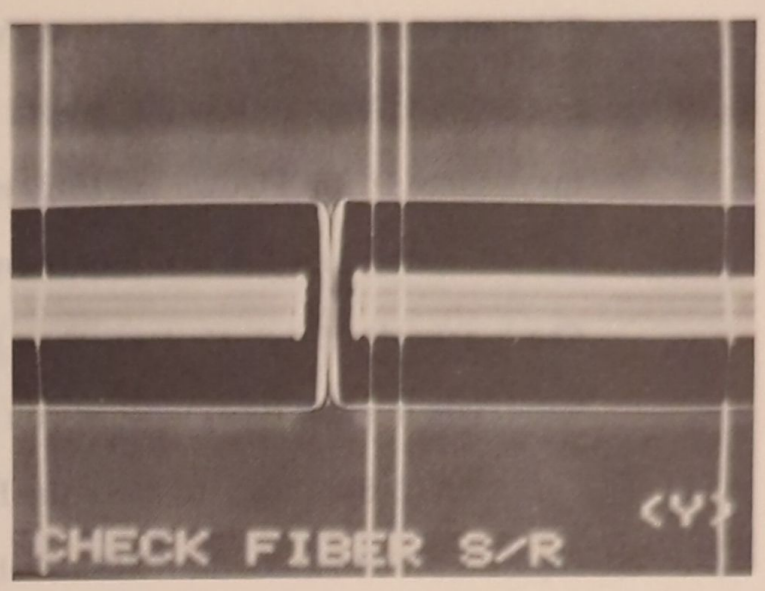
In case of no shift in (Y), the CSHIFT must be zero so the Dip Sw 3 Bit 6-8 must be set as CASE (A) in above table.

In case of right shift in (Y), the CSHIFT is positive, so the dip switches must be set as CASE (B) in above table.

In case left shift in (Y), the CSHIFT is negative, so the dip switches must be set as CASE (C) in above table.



(B): Right shift in (Y)



(C): Left shift in (Y)

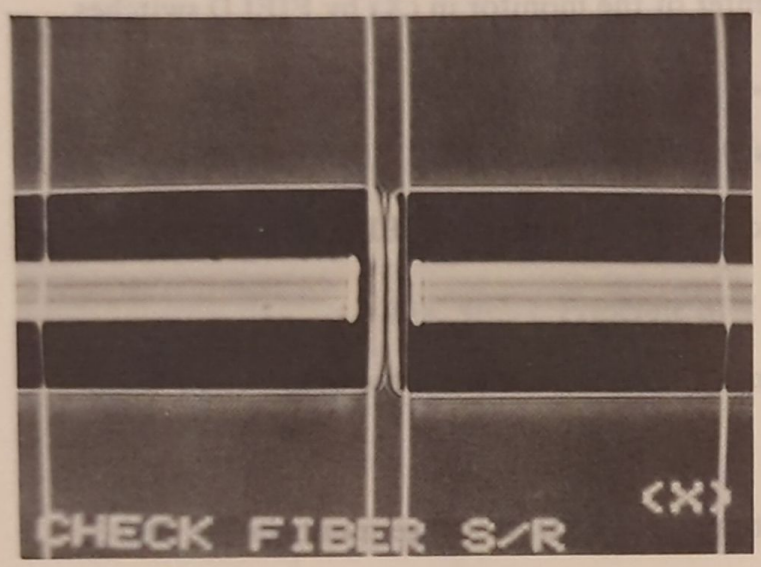
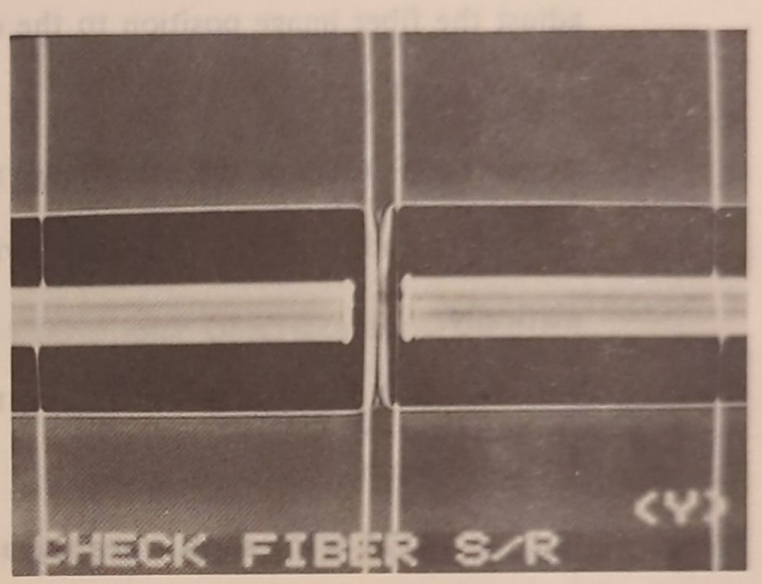


Image in (X)



(A): No shift in (Y)

Fig. 362-1 Gap Position Shift in FIELD Exchange from (X) to (Y)

(9) Time during which FOCUS and FIELD motors move in automatic FIELD exchange operation, TFFM.

Dip Sw 4 Bit 1 ~ 3

Bit 1	Bit 2	Bit 3	TFFM (sec)
0	0	0	2.0
1	0	0	2.5
0	1	0	3.0
1	1	0	3.5
0	0	1	4.0
1	0	1	4.5
0	1	1	5.0
1	1	1	5.5

This splicer visuallize the (X) and (Y) image of the fiber in principle as shown in Fig. 362-2. Therefore the TV camera must move by the distance D1 for FIELD and the distance D2 for FOCUS in FIELD exchanging from (X) to (Y) or vice versa.

The distances D1 and D2 are decided by the distance between the fiber and the mirror. Check according to next steps when the automatic FIELD exchange does not work well (takes too long time) or when you replace the mirror.

① Turn off Dip Sw 5 Bit 5 to make the FIELD switch function manual and turn on the Dip Sw 5 Bit 6 to make the AXIS switch function for ZL & ZR.

② Set the optical fiber on the V groove and move the fiber forward along Z-axis then adjust the fiber image position to the center of the monitor in (X) by FIELD switches as shown in Fig. 362-3 (A).

③ Adjust the FOCUS of the fiber image as shown in Fig. 20 (P32) then turn on the Dip Sw 5 Bit 5 and push one of FIELD switches to exchange the FIELD (X) to (Y) automatically.

④ The FIELD & FOCUS motors driving time TFFM is good when the automatic FIELD exchange results in Fig. 362-3 (B).

But the TFFM is too short when the automatic FIELD exchange results in Fig. 362-3 (C) or (D). In this case increase the TFFM by Dip Sw 4 Bit 1 ~ 3.

The TFFM is too long when the automatic FIELD exchange results in Fig. 362-3 (E). In this case decrease the TFFM by Dip Sw 4 Bit 1 ~ 3.

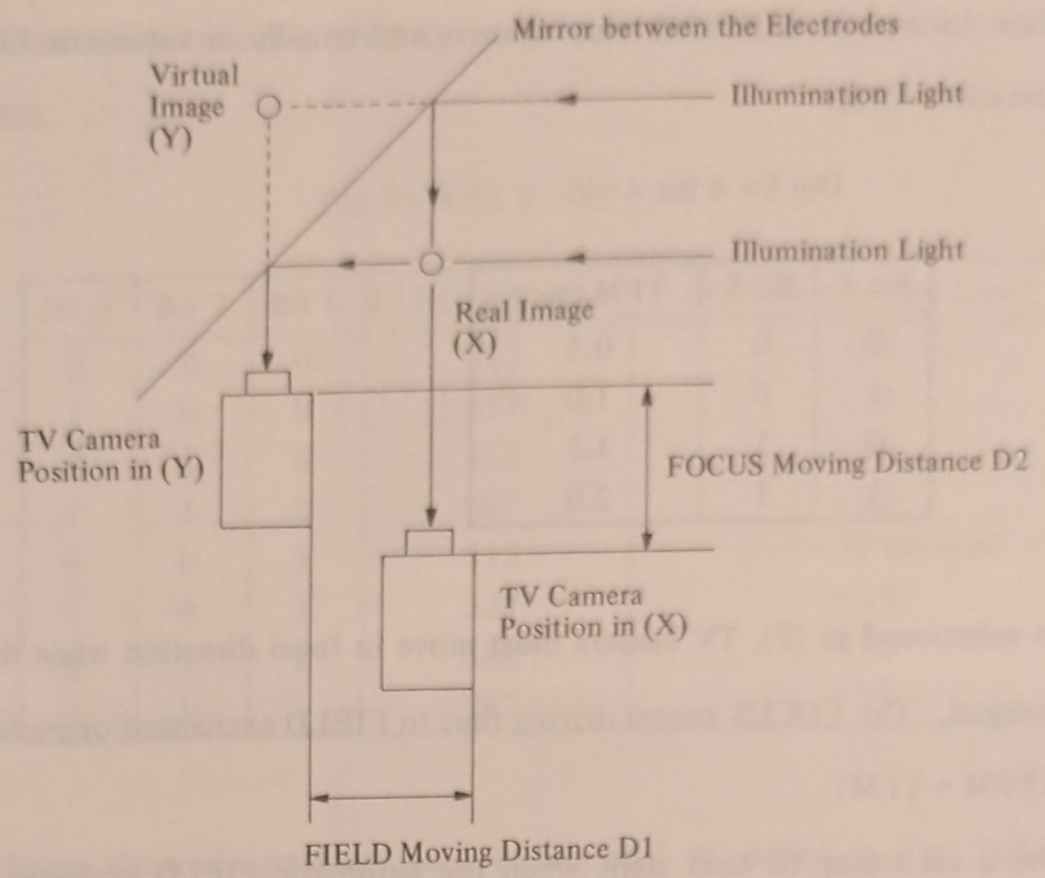


Fig. 362-2 Principle of Two Directional Observation

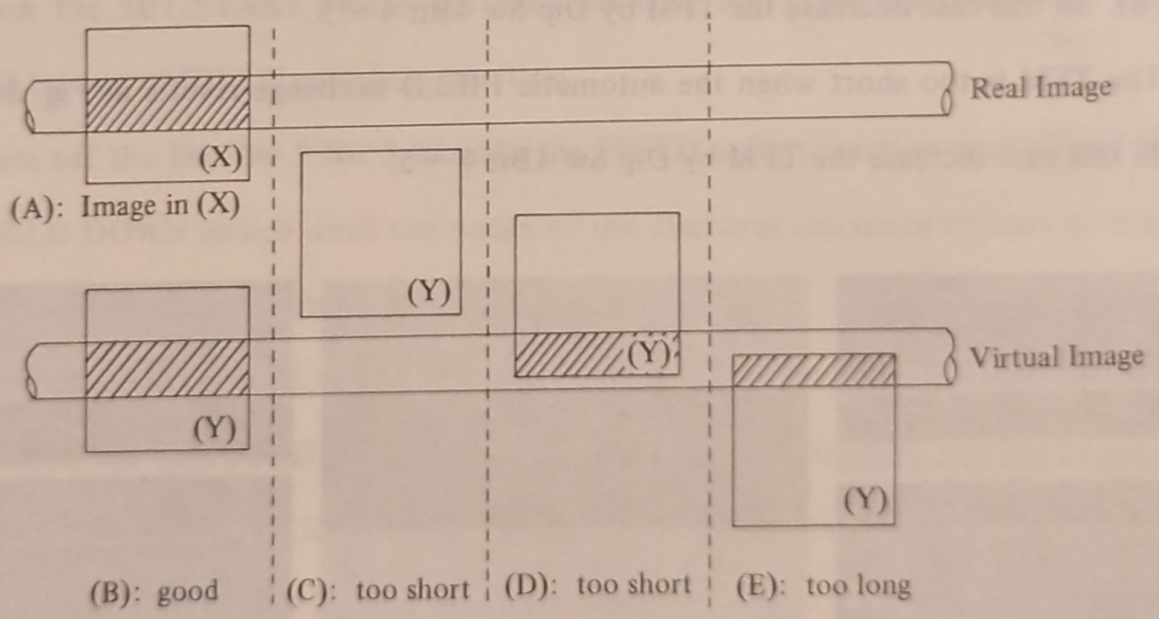


Fig. 362-3 Example of FIELD & FOCUS Motors Driving Time TFFM
in Automatic FIELD Exchange from (X) to (Y)

(10) Time during which FOCUS motor moves additionally in automatic FIELD exchange operation, TFM.

Dip Sw 4 Bit 4 ~ 5

Bit 4	Bit 5	TFM (sec)
0	0	0.5
1	0	1.0
0	1	1.5
1	1	2.0

As mentioned in (9), TV camera must move in focal direction when the FIELD is exchanged. The FOCUS motor driving time in FIELD exchanged operation is decided as (TFFM + TFM).

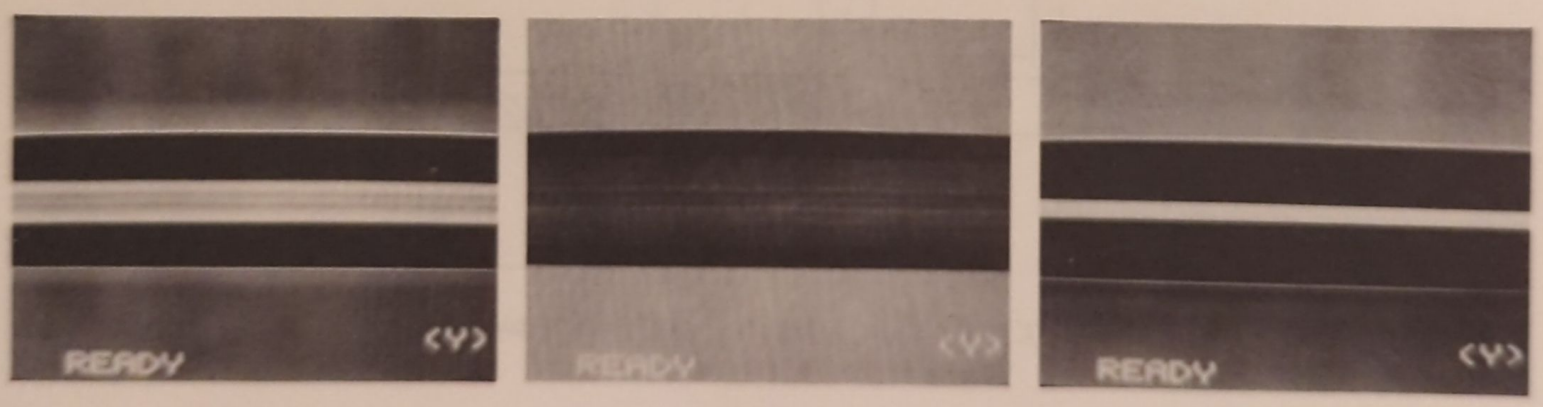
Check according to next steps when the automatic FIELD exchange does not work well (takes too long time) or when you replace the mirror.

① Follow the steps (9) ① ~ ③ .

② The TFM is good when the automatic FIELD exchange results in Fig. 362-4 (A).

But the TFM is too long when the automatic FIELD exchange results in Fig. 362-4 (B). In this case decrease the TFM by Dip Sw 4 Bit 4 ~ 5.

The TFM is too short when the automatic FIELD exchange results in Fig. 362-4 (C). In this case increase the TFM by Dip Sw 4 Bit 4 ~ 5.



(A): good (B): too long (C): too short

Fig. 362-4 Examples of Additional FOCUS Motor Driving Time TFM in Automatic FIELD exchange from (X) to (Y)

(11) Gap set position to be adjusted to discharge electrode image position on the monitor, ELECTRD.

Dip Sw 4 Bit 6 ~ 8

Bit 6	Bit 7	Bit 8	ELECTRD (line)	Shift from center (line)
0	0	0	412	−100
1	0	0	437	−75
0	1	0	462	−50
1	1	0	487	−25
0	0	1	512	0 (center)
1	0	1	537	+25
0	1	1	562	+50
1	1	1	587	+75

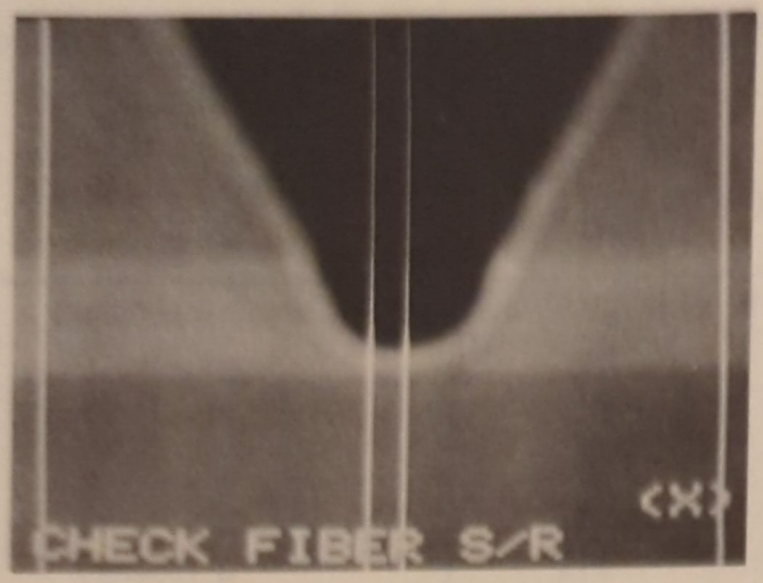
The discharge electrode position must be adjusted as shown in Fig. 362-5 (A) to ensure both fibers to be heated equally. Take the following steps when you cannot get the good splice.

① Turn on the Dip Sw 5 Bit 5 and 8 to make the FIELD switch function automatic and to pause the splicing sequence after GAP SETTING is done.

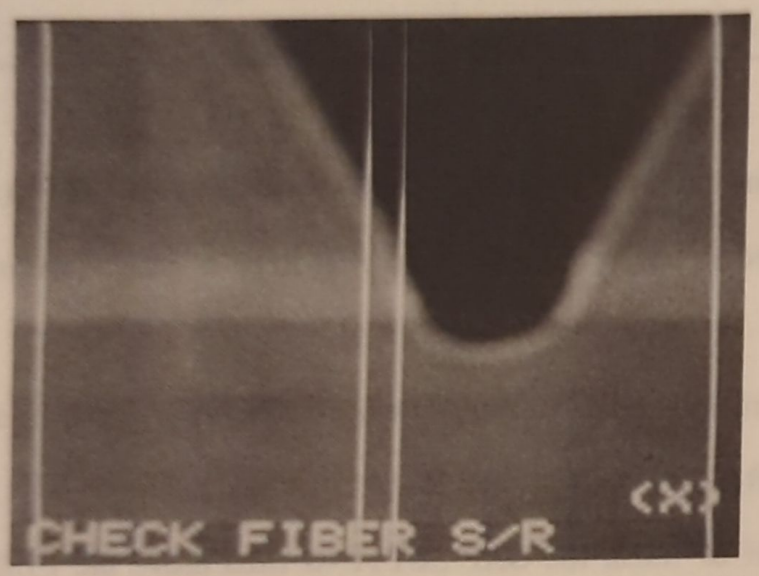
② Push the SET/START switch to finish the GAP SETTING then move the FIELD to (X) by one of FIELD switches operation.

③ Turn off the Dip Sw 5 Bit 5 to make the FIELD switch function manual and push the FIELD DOWN switch until the image of the discharge electrode appears on the top of the monitor image as shown in Fig. 362-5.

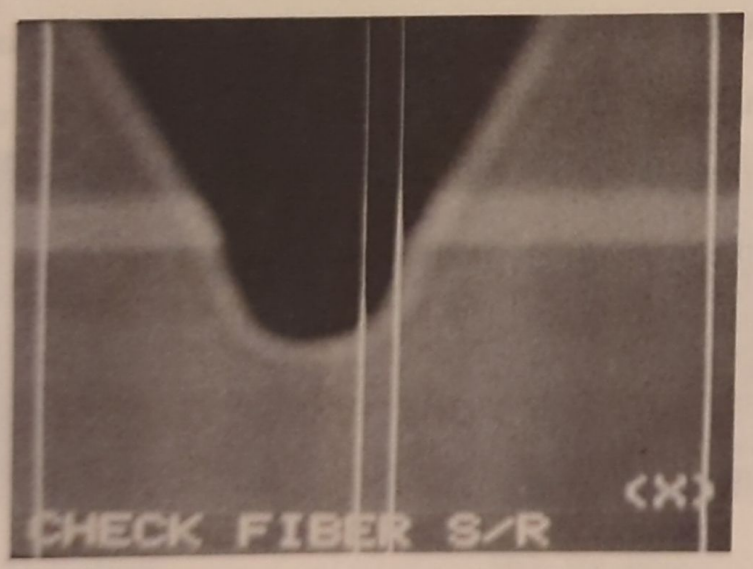
④ The ELECTRD is good when the monitor image is as shown in Fig. 362-5 (A).
Increase the ELECTRD when the electrode image position shifts to right as in (B), and decrease the ELECTRD when the electrode image position shifts to left as in (C) so that the monitor image becomes such as in (A).



(A): Good
The needle point of electrode is just on the right center cursor.



(B): Right shift



(C): Left shift

Fig. 362-5 Examples of Discharge Electrode Position

(12) ON or OFF of ECF, ECF

Dip Sw 5 Bit 1 1 = ON, 0 = OFF

(13) ON or OFF of data display, DISPLAY

Dip Sw 5 Bit 2 1 = ON, 0 = OFF

When this switch is ON, detected core axis offsets, fiber axis offsets and eccentricity on each cursor line are displayed on the monitor during automatic ALIGNING and LOSS ESTIMATION in the format of Fig. 35 (P49).

Only the fiber axis offsets are displayed during ALIGNING in case of GI mode splicing since the splicer aligns the fiber axis and does not estimate loss.

(14) ON or OFF of core diameter check, CDCHECK

Dip Sw 5 Bit 3 1 = ON, 0 = OFF

This switch should be always OFF since this function disturbs the automatic aligning except for the fibers that have the core diameter of 9 ~ 10 μm.

(15) Selection of operating parameters source

Dip Sw 5 Bit 4 1 = Dip Switch, 0 = BTRAM

This switch must be ON except for the case changing the operating parameters by the external portable computer connected to the controller as shown in Fig. 13 (P24).

(16) Selection of FIELD switch function, FIELD SW.

Dip Sw 5 Bit 5 1 = AUTO, 0 = MANUAL

Refer to Table 4 ㉝ , P11.

(17) Selection of AXIS switch function, AXIS SW.

Dip Sw 5 Bit 6

1: XF→ZLF, XR→ZLR, YF→ZRF, YR→ZRR

0: X, Y

Refer to Table 4 ㉗ , P10

(18) ON or OFF of short discharge to remove dust, LITARC

Dip Sw 5 Bit 7 1 = ON, 0 = OFF

The discharge is produced for 0.2 sec to remove dust on fiber surface at the middle of GAP SETTING when the Dip Sw 5 Bit 7 is ON.

(19) ON or OFF of pausing sequence after GAP SETTING, PAUSE

Dip Sw 5 Bit 8 1 = ON, 0 = OFF

When the Dip Sw 5 Bit 8 is ON, the splicing sequence is paused just after the GAP SETTING is done until the SET/START switch is pushed again.

The splicing sequence has no pause when the Dip Sw 5 Bit 8 is OFF.

3.7 Operating Method of Ultra-sonic Cleaner (This equipment is an optional accessory.)

After setting up the ultra-sonic cleaner according to 3.2.2, turn on the power switch ㊻ and the power lamp ㊺ lights up.

Immense the cleaved optical fiber gently into alcohol as shown in Figure 27 for 5~10 seconds. Then turn off the power switch ㊻ without fail.

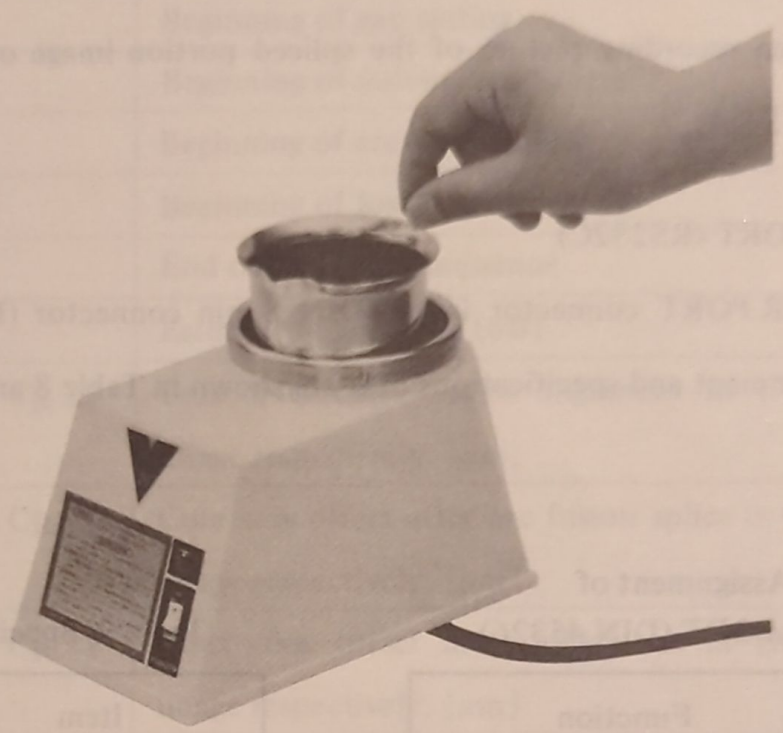


Fig. 27 Cleaning the Optical Fiber

3.8 Operating Method of the Portable Computer

Type FSM-20 splicing controller has the RS232C connector (labeled "SER.PORT" on the switch panel) for data communication to the external portable computer. The following functions are available by connecting the portable computer to the SER.PORT.

(1) The splicing controller transmits signals indicating in which step the system is operating and indicating splice loss etc. Therefore, for example, daily work report can be made by taking advantage of it. (Refer in detail to 3.8.2)

(2) The splicing controller can store arc fusion splicing parameters onto the battery backupped RAM (hereafter called BTRAM, installed inside the controller) from the portable computer. The data on the BTRAM is reserved even after the POWER switch of the

splicing controller is turned off. (Refer in detail to 3.8.3)

Thus the splicing controller can have splicing parameters both on the dip switches and on the BTRAM. You can select out the splicing parameters either on the dip switches or on the BTRAM by turning ON or OFF the Bit 4 of the Dip sw 5 respectively. (ON = Dip switch parameters, OFF = BRTAM parameters)

(3) The splicing controller can store characters and numerals of 20x12 size as message on the BTRAM and can display them on the monitor. For example, these messages can be used when recording picture of the spliced portion image on the monitor. (Refer in detail to 3.8.4)

3.8.1 SER.PORT (RS232C)

The SER.PORT connector is the DIN 8 pin connector (DIN standard No.45326). The pin assignment and specifications of it are shown in Table 8 and 9 respectively.

Table 8 Pin Assignment of SER.PORT (DIN 45326)

No.	Name	Function
1	GND	Signal ground
2	TxD	Transmission data
3	RxD	Receive data
4	RS	Request to send
5	CS	Clear to send
6	DR	Data set ready
7	ER	Data terminal ready
8	CD	Carrier detection

Table 9 Specifications of SER.PORT

Item	Description
Communication mode	Asynchronous
Baud rate	2400
Start bit length	1 bit
Data bit length	8 bit
Stop bit length	1 bit
Parity	None

NOTE: ○ Pin No. 4–5 and 6–7 are shorted inside the controller.

○ Pin No.8 is not connected (open).

3.8.2 Data Transmission from the splicing controller

The splicing controller transmits following data shown in Table 10 to the SER.PORT at the beginning of each step.

Table 10 Data Format Transmitted by the Splicing Controller

Data Format	Meaning
R C_R L_F	Beginning of reset operation
S C_R L_F	Beginning of gap setting
B C_R L_F	Beginning of automatic aligning
A C_R L_F	Beginning of arc fusion splice
I C_R L_F	Beginning of loss estimation
E C_R L_F	End of one splice sequence
L □ □ · □ □ C_R L_F	Estimated splice loss [dB]
M □ □ · □SP□ □ · □ C_R L_F	Core axis offset after alignment in (X) and (Y) image respectively. [μm]
N □ □ · □SP□ □ · □ C_R L_F	Core axis offset after arc fusion splice in (X) and (Y) image respectively. [μm]
O □ □ · □SP□ □ · □ C_R L_F	Fiber axis offset after alignment in (X) and (Y) image respectively. [μm]
P □ □ · □SP□ □ · □ C_R L_F	Fiber axis offset after arc fusion splice in (X) and (Y) image respectively. [μm]
Enq C_R L_F	The external computer requests the splicing controller to resend the signal.

NOTE: 1. All those characters are inform of ASCII code (American National Standard Character for Information Interchange). □'s denote numerals. For example

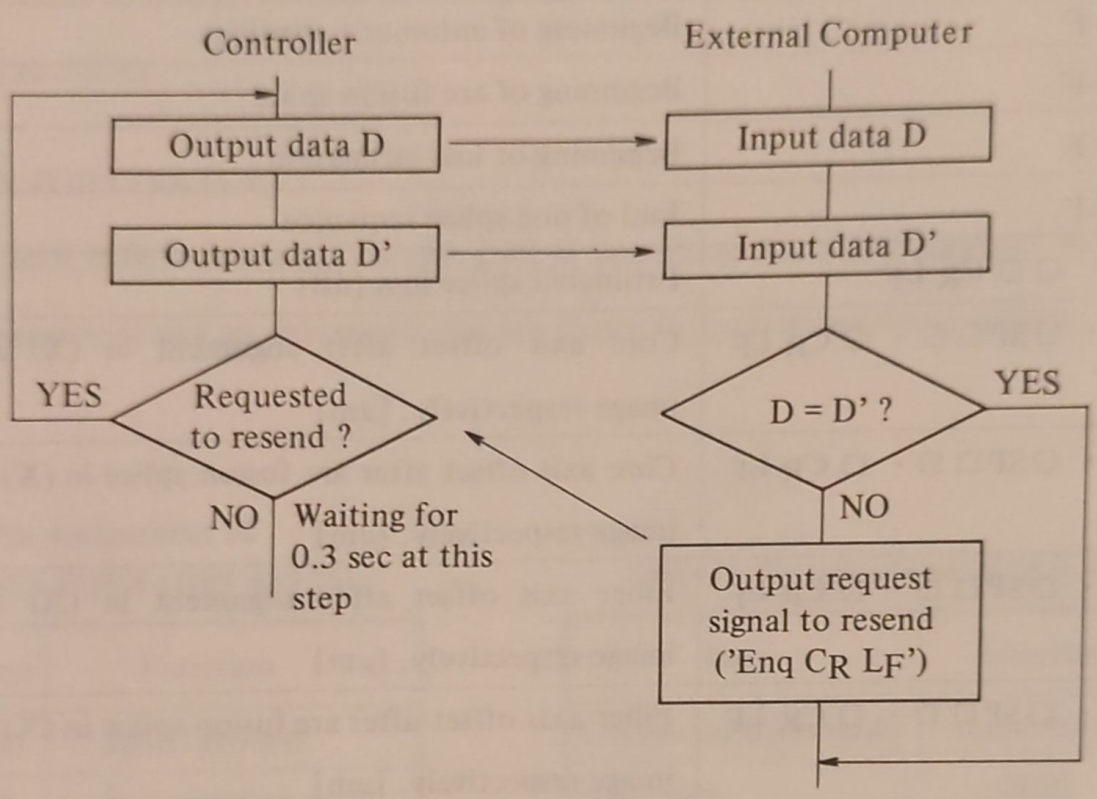
M 0 1 · 3 SP 2 5. 7 C_R L_F is equal to

4D 30 31 2E 33 20 32 35 2E 37 0D 0A in HEX and it means the core axis offset in (X) is 1.3μm and in (Y) is 25.7μm.

2. Enq C_R L_F (05, 0D, 0A) is assigned external computer's word meaning "Request the splicing controller to resend the signal."

3. In the GI mode, the splicing controller does not transmit the estimated splice loss, fiber axis offset after arc fusion splice and core axis offset.
4. One data output of the splicing controller is completed by sending the same data twice. Therefore the data communication between the controller and the external computer comes to have the following sequence.

Flow Chart of Data Communication



The controller waits for teh request-to-send signal for 0.3 second after sending one data twice. If the controller receives the request-to-resend signal ten times succeedingly, the controller neglects the signal and goes ahead to the next step.

3.8.3 Operation parameters setting by the portable computer

The external portable computer can set the operation parameters on the BTRAM inside the splicing controller. This function is available only when the splicing controller is in its "READY" state. Use the following format shown in Table 11 when sending parameters from the external computer.

Table 11 Data Format of Parameters

Paramter	Data Format	Setting Region	Unit
ARCPWR	P □ □ □ □ C_R L_F	0~31	(NOTE 3)
TARCS	S □ □ □ □ C_R L_F	0~65	sec
TARCM	M □ □ □ □ C_R L_F	0~65	sec
TFORW	F □ □ □ □ C_R L_F	0~1000	msec
PREFUS	R □ □ □ □ C_R L_F	0~1000	msec
GAP	G □ □ □ □ C_R L_F	0~32	line (NOTE 3)
ECFCOF	I □ □ □ □ C_R L_F	0~0.9	
ECF	O □ C_R L_F	1=ON, 0=OFF	
Parameter display on the monitor	! C_R L_F		(NOTE 3)

ABBREVIATIONS:

ARCPWR = Discharge power

TARCS = Discharge time in the SM mode

TARCM = Discharge time in the GI mode

TFORW = Time during which the fiber moves forward during discharge

PREFUS = Prefusion time

GAP = Initial gap of fiber end faces

ECFCOF = Coefficient of Eccentricity Correct Function (Refer to APPENDIX (A))

ECF = ON or OFF of Eccentricity Correct Function

NOTE: 1. All characters are in form of the ASCII code and □'s in Table 11 denote numerals. The controller receive the data only once and does not check it. The maximum data length is 27 characters including the first character (P,S, M ..... O), C_R and L_F.

2. Discharge current I_A is approximately

$$I_A = 12 + 0.3 * \text{Data [mA]}$$

For example, when " P 1 2 C_R L_F " is sent, discharge current is about 15.6mA.

3. The resolution of one line is about 0.35μm.

4. Be sure to check the parameters after sending them by executing this command.

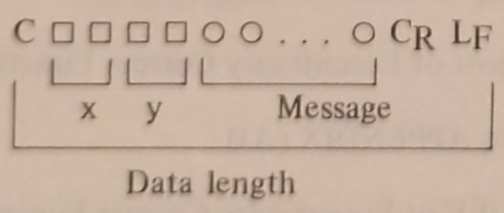
The splicer main body acknowledges all those parameters when the external computer sends the "!" command to the splicing controller or when the RESET switch is depressed. The controller displays the dip switch parameters or the BTRAM parameters according to the Bit 4 of Dip Sw 5 is ON or OFF respectively. (Refer to Table 5)

3.8.4 Message display on the monitor

The monitor ㊳ of the splicing controller has the 20x12 size of message display area as shown in Fig. 28. Available ASCII characters are shown in APPENDIX (B). Message display is done by following steps.

(1) Write the message on the BTRAM

Send the data of following format to the splicing controller from the external computer.



x: Displaying start address in x axis (ASCII code)

y: Displaying start address in y axis (ASCII code)

The maximum data length is 27 characters. The controller receives the data only once and does not check it.

(2) Display on the monitor

Send " ? C_R L_F " to the splicing controller from the external computer. The controller displays all characters in 20x12 size of the BTRAM display area.

(3) Delete the characters on the BTRAM display area

Send " % C_R L_F " to the splicing controller from the external computer. The controller fills up the BTRAM area with SP (20H) and display them on the monitor. All characters on the monitor can be deleted with the BTRAM data reserved when the "RESET" switch is pushed.

Example: When following data are sent to the controller, the monitor displays such as shown in Fig. 28.

"C0101␣SPLICED␣BY␣FUJIKURA C_R L_F "

"C0503 '85␣APR.␣17th C_R L_F "

"? C_R L_F "

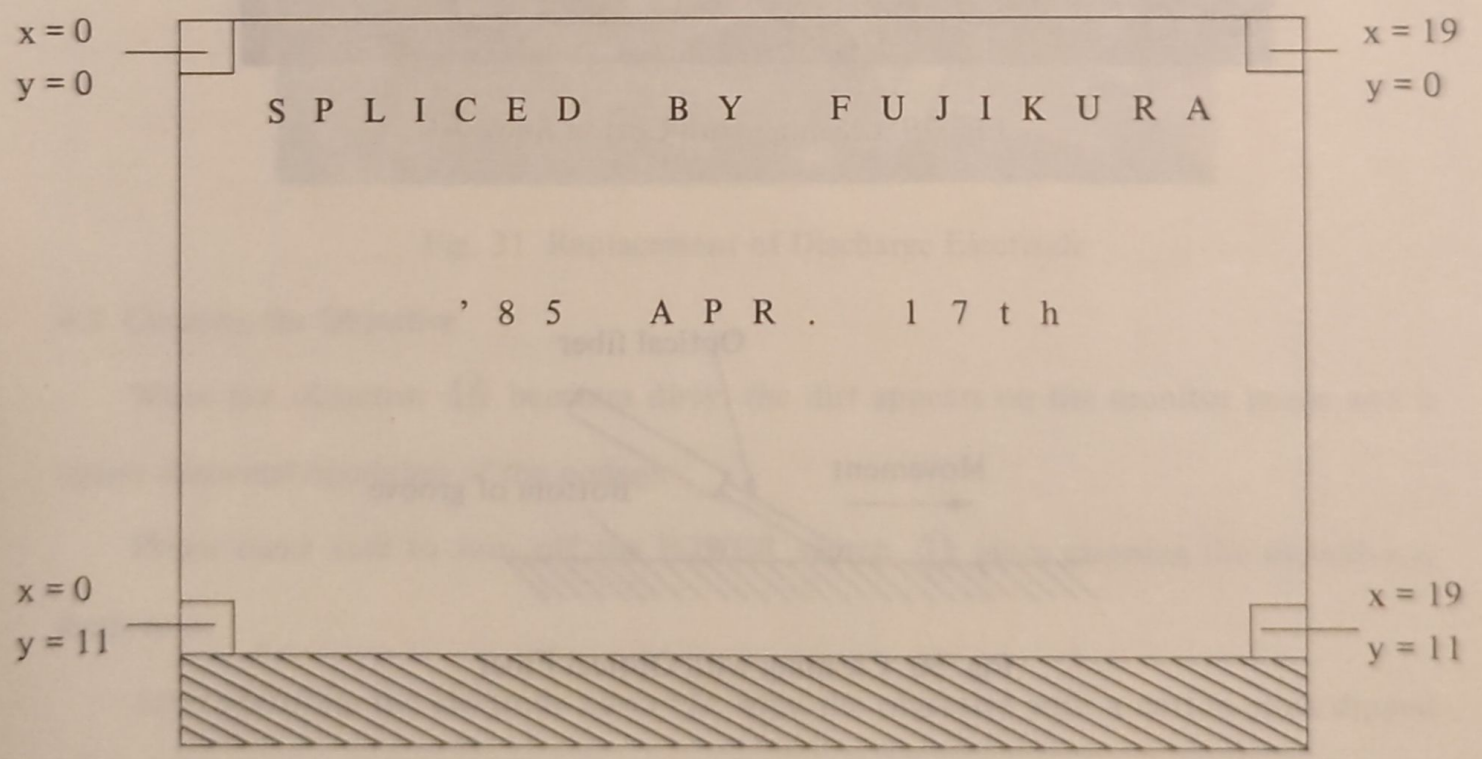


Fig. 28 Message Display on the Monitor

4. MAINTENANCE

4.1 Cleaning the Optical Fiber Guide Unit

When the groove of the optical fiber guide unit ⑧ becomes dirty, it may cause axial distortion of the optical fiber.

Please make sure that you have turned off the POWER switch ㉛, since it is dangerous to clean the optical fiber guide unit when the power is on. After opening the clamp ⑪, wipe the groove with a cotton stick dipped in alcohol (Refer to Fig. 29). Alternatively scour the groove with the end face of the cut optical fiber in the direction shown in Fig. 30. Discharge several times (caution (3) Sect. 5.1) without fail, after cleaning.

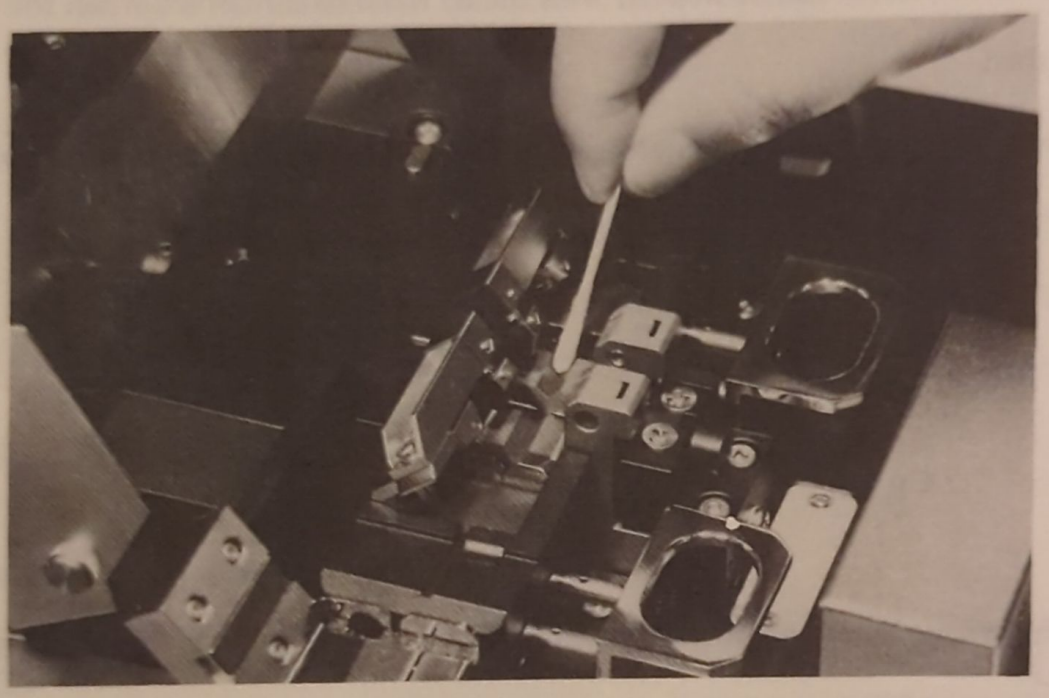


Fig. 29 Cleaning with Cotton Stick

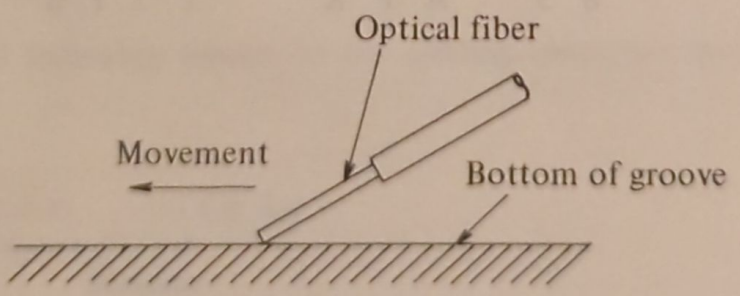


Fig. 30 Cleaning with Optical Fiber

4.2 Replacement of Discharge Electrode

When the discharge electrode ⑬ is extremely worn down, it may cause increase splice loss or separation at the fusion splicing point of the optical fiber.

Since the replacement of the electrode is dangerous, please make sure to turn off the POWER switch ㉛. After removing the electrode cover ①, loosen the screws of the electrode stator ⑫ and then pull out the discharge electrode ⑬. (Rerfer to Fig. 31) Put in the new discharge electrode ⑬, tighten the screws and then put on the electrode cover. Be careful not to deform the needle point of the electrode. Such deformation may cause the abnormal discharge. When you need to replace a discharge electrode, please replace both electrodes in pair. After replacing, discharge several times without fail (Refer to Section 5.1 Caution (3)).

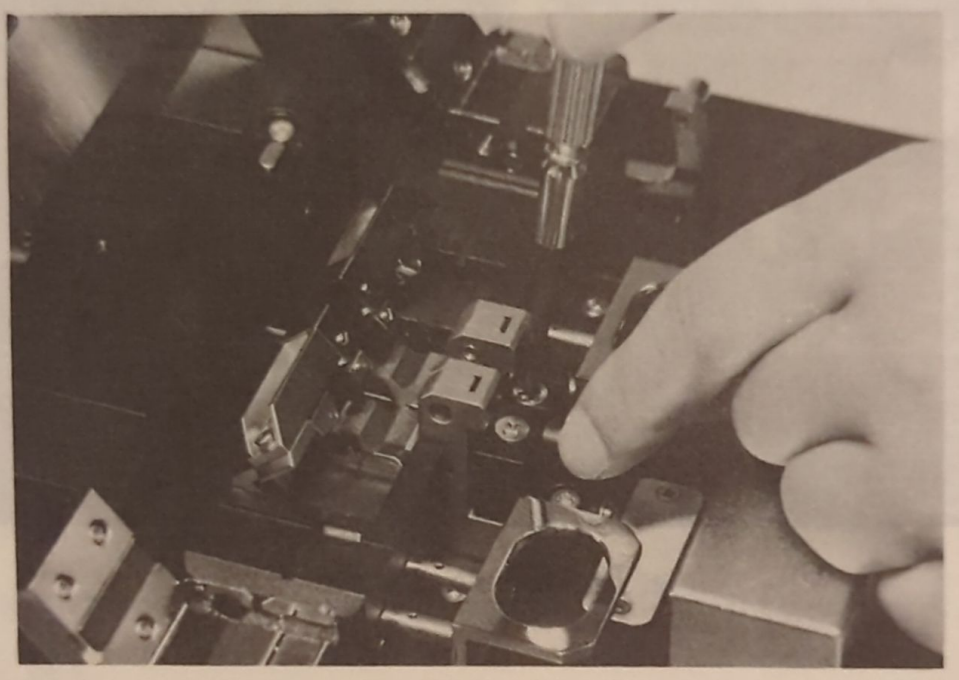


Fig. 31 Replacement of Discharge Electrode

4.3 Cleaning the Objective

When the objective ⑯ becomes dirty, the dirt appears on the monitor image and it causes abnormal operation of the system.

Please make sure to turn off the POWER switch ㉛ since cleaning the objective is dangerous.

After removing the electrode cover ①, wipe the objective with a cotton stick dipped in alcohol. (Refer to Fig. 32). Discharge several times without fail after cleaning (Refer to Section 5.1 Caution (3)).

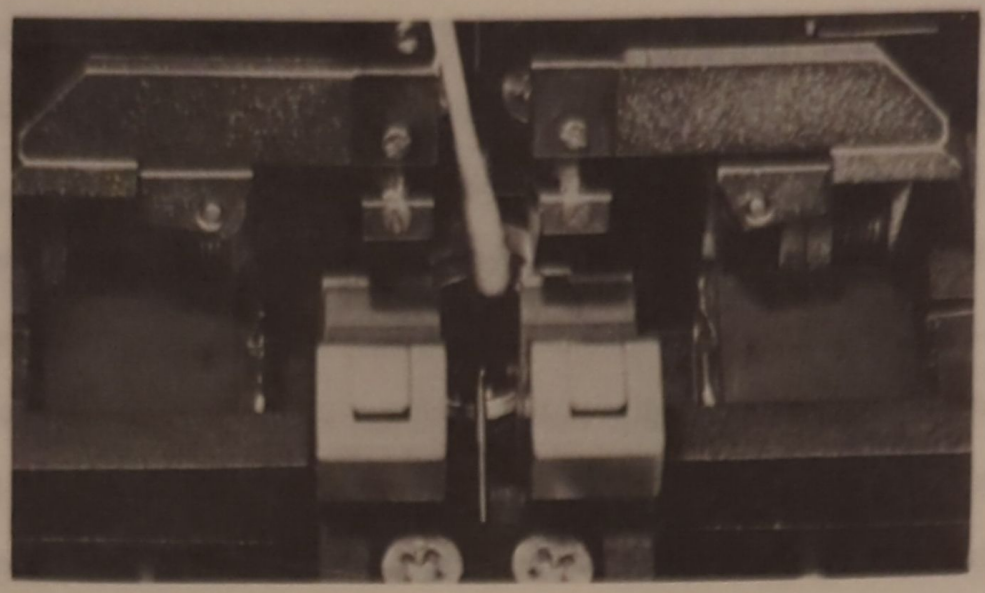


Fig. 32 Cleaning the Objective

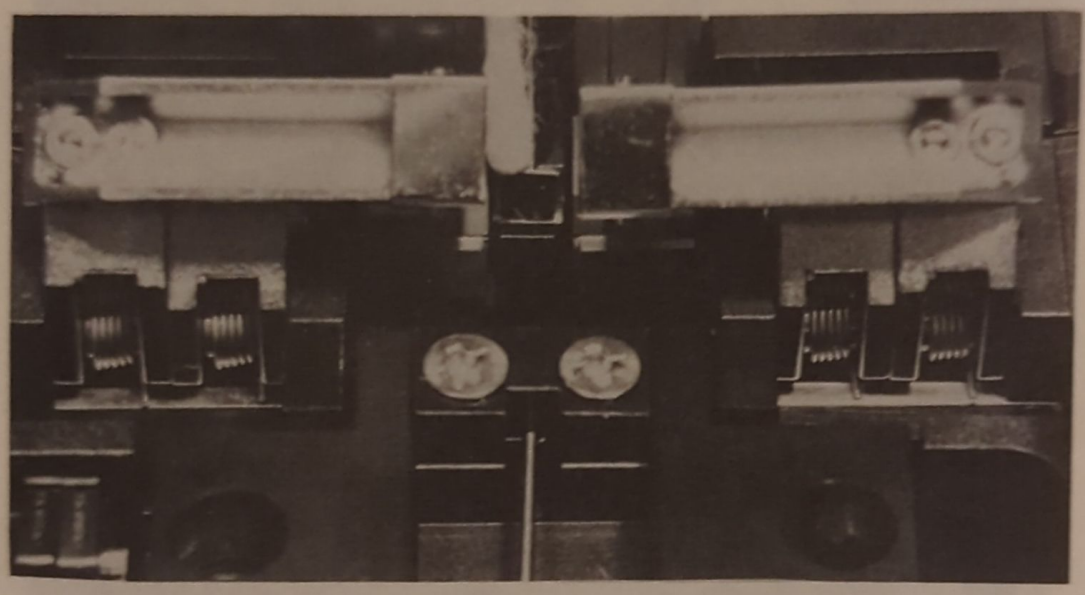


Fig. 33 Cleaning the Mirror

4.4 Cleaning the Mirror

When the mirror ⑨ and the mirror inside the wind protector ④ becomes dirty, the dirt appears on the monitor and it causes abnormal operation of the system.

Cleaning procedures are following.

(1) Push the MIRROR ON switch ㉘ to insert the mirror ⑨ and be sure to turn OFF the POWER switch of the controller.

(2) Open the wind protector ④, then loosen electrode stating screws ⓐ and pull the electrode to rear side of the splicer. (Refer to Fig. 34)

(3) Wipe the mirror ⑨ and the one inside the wind protector with cotton stick dipped in alcohol as shown in Fig. 33.

But if the mirror has the large visible dust like sand on its surface, blow then away before wiping. Otherwise such dust produces blemish on the mirror in wiping.

(4) Push the electrode back to front side of the splicer until the flange of the electrode touches electrode stator as shown in Fig. 34, then tighten the electrode stating screws ⓐ.

4.5 Replacement of the Mirror

When the mirror has large blemish on its surface, the blemish appears on the monitor and it causes abnormal operation of the system.

In this case the mirror ⑨ must be replaced. Replacement procedures are following. (Refer to Fig. 34.)

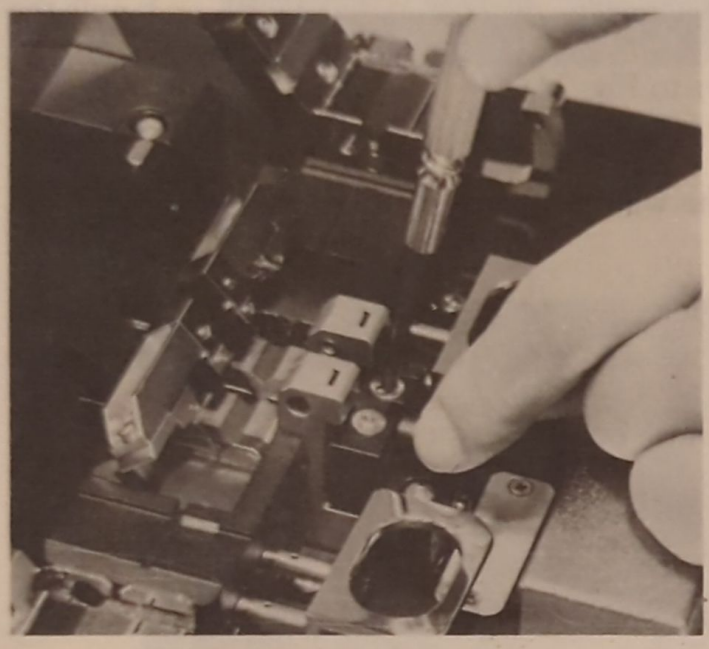
(1) Push the MIRROR ON switch ㉘ to insert the mirror ⑨ and be sure to turn OFF the POWER switch of the controller.

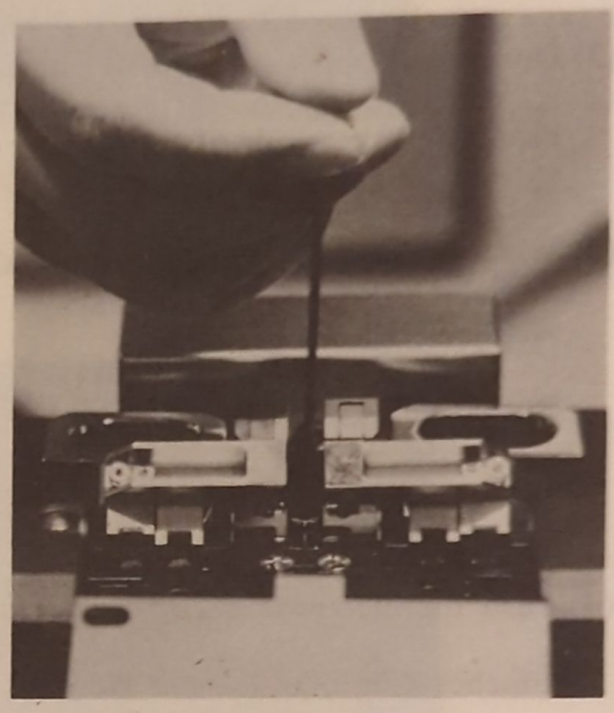
(2) Open the wind protector then loosen the electrode stating screws ⓑ and pull out the electrode to the front side of the splicer.

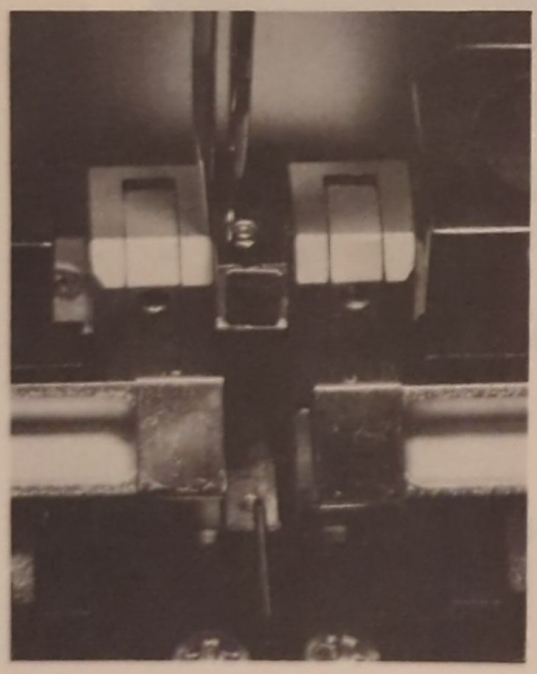
(3) Loosen the screws of the mirror attachment ⓒ and take out the mirror attachment ⓓ.

(4) Set the spare mirror attachment to the mirror holder ⓔ and tighten screws ⓒ while pushing the mirror attachment to touch the Ⓐ surface.

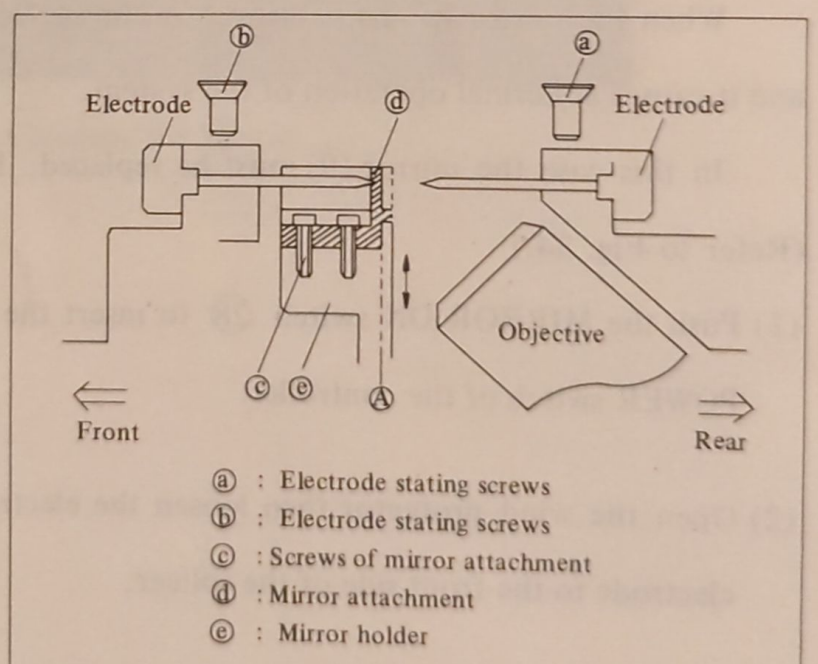
(5) Insert the electrode until the flange of the electrode touches the electrode stator, then tighten screws ⓑ. Be careful that the needle point does not hit any part of the splicer. It causes deformation of the electrode and results in abnormal discharge.







(c) Taking out the mirror attachment

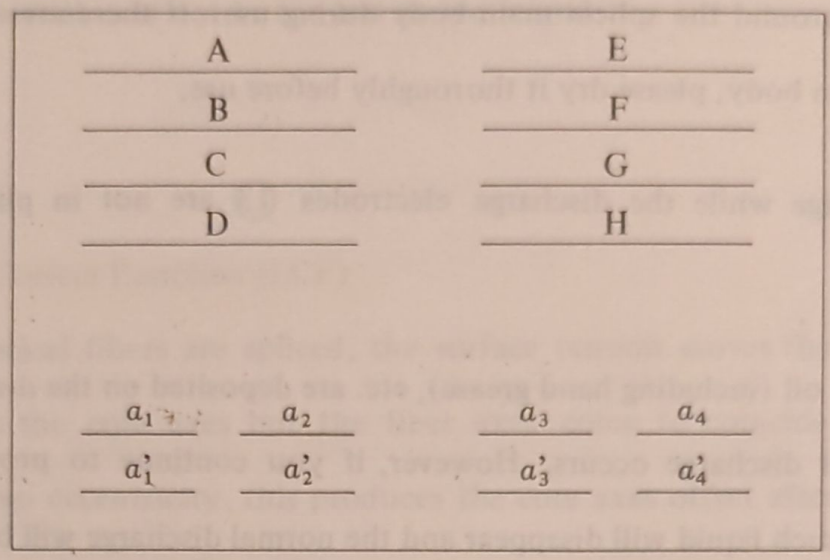


(c) Cross sectional view around the mirror and objective

Fig. 34 Replacement of the Mirror

4.6 Adjustment Method of Discharge Power

(1) Turn on bit 2 of Dip Sw 5 to display data during automatic splice as shown in Fig. 35.



A : Core axis offset after aligned in (Y) [line]

B : Core axis offset after aligned in (X) [line]

C : Core axis offset after spliced in (Y) [line]

D : Core axis offset after spliced in (X) [line]

E : Fiber axis offset after aligned in (Y) [line]

F : Fiber axis offset after aligned in (X) [line]

G : Fiber axis offset after spliced in (Y) [line]

H : Fiber axis offset after spliced in (X) [line]

$a_1 \sim a_4$: Eccentricity on each cursor line [line]

$a_1' \sim a_4'$: Remeasured eccentricity on each cursor line [line]

Fig. 35 Data Diplayed on the Monitor During Automatic Splice

(2) Prepare the optical fiber having the largest eccentricity.

(3) Discharge power is appropriate if the difference between E and G and the difference between F and H are within ±1 line after usual splice.

Discharge power is too small if G>E and H>F.

Discharge power is too large if G<E and H<F.

5. CAUTIONS

5.1 Cautions During Operation

(1) During discharge, the electrode generates a voltage of about 4,000V. Do not touch it! Make sure to ground the splicer main body during use. If there are drops of water on the splicer main body, please dry it thoroughly before use.

(2) Do not discharge while the discharge electrodes ⑬ are not in place. It may cause problems.

(3) When alcohol, oil (including hand grease), etc. are deposited on the discharge electrodes ⑬, abnormal discharge occurs. However, if you continue to produce a discharge several times, such liquid will disappear and the normal discharge will be produced.

(4) You must turn the POWER switch OFF before you remove or connect the power cord and the controlling cable from or to the splicer main body and the splicing controller.

(5) You must not clean the objective ⑯, switches or panels with any chemical except for alcohol. Such chemicals may cause changes in color, quality, etc.

(6) Be careful not to get dust or sand on the splicer main body. The optical fiber guide unit ⑧ has been specially manufactured and should not be rubbed with hard materials such as metal or the like.

(7) It is not necessary to oil the splicer main body. Oiling may cause problems in its operation.

(8) Since precise adjustments were made to the fusion splicer main body before it left the factory, please do not loosen screws, etc. If there is something wrong with the splicer, consult with the manufacturer.

5.2 Cautions in Storage and Transportation

(1) Since fine adjustments have been made to the fusion splicer main body, please place it in the container box to protect it against humidity, vibration and shock.

(2) The storage room should not be too hot or too humid.

APPENDIX

(A) Eccentricity Correct Function (ECF)

When the optical fibers are spliced, the surface tension moves the fibers during discharge so that not the core axes but the fiber axes come to coincide. Therefore when the fibers have large eccentricity, this produces the core axes offset after splice preventing the low splice loss as shown in Fig. 36 (a).

This splicer can compute the moving distance by the surface tension using the eccentricity of fibers measured during alignment. Taking advantage of this, the splicer can shift the core axes intentionally after aligning so that the core axes recover to coincide after splice as shown in Fig. 36 (b). This function is called "Eccentricity Correct Function (ECF)".

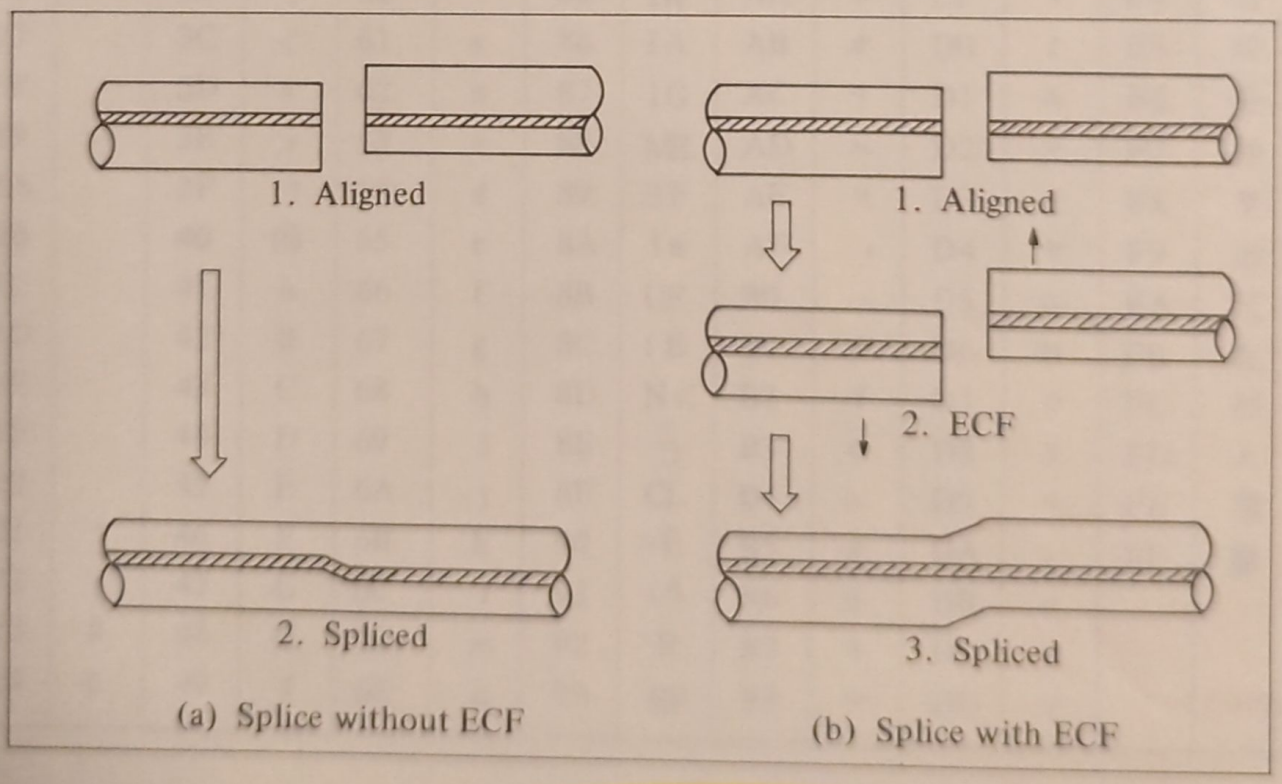


Fig. 36 Effect of ECF

The moving distance d of the optical fiber axes is

$$d = KD = [1 - \exp(-\frac{2T}{RU} t)]D$$

T : Surface tension

R : Fiber radius

U : Viscosity of melt glass

t : Discharge time

D : Initial fiber axis offset

Then the distance a to be shifted intentionally is

$$a = \frac{K}{1 - K} D$$

D : Fiber axis offset after aligned

K : ECF coefficient

(ECFCOF, the bits 1~4 of Dip Sw 2 in Table 5)

(B) ASCII Code Table Supported by the Splicing Controller

CODE	CHR.	CODE	CHR.	CODE	CHR.	CODE	CHR.	CODE	CHR.	CODE	CHR.	CODE	CHR.
00		25	%	4A	J	6F	o	94	⌇F	B9	ケ	DE	゛
01		26	&	4B	K	70	p	95	IS	BA	コ	DF	゜
02		27	’	4C	L	72	q	96	EF	BB	サ	E0	＝
03		28	(	4D	M	71	r	97	⌇	BC	シ	E1	⊨
04		29	)	4E	N	73	s	98	AL	BD	ス	E2	≠
05		2A	*	4F	O	74	t	99	-L	BE	セ	E3	⫤
06		2B	÷	50	P	75	u	9A	C	BF	ソ	E4	◢
07		2C	,	51	Q	76	v	9B	LE	C0	タ	E5	◣
08		2D	−	52	R	77	w	9C	≥▪	C1	チ	E6	◥
09		2E	‘	53	S	78	x	9D	Θ	C2	ツ	E7	◤
0A		2F	/	54	T	79	y	9E	、	C3	テ	E8	♠
0B		30	0	55	U	7A	z	9F	′	C4	ト	E9	♥
0C		31	1	56	V	7B	{	A0		C5	ナ	EA	◆
0D		32	2	57	W	7C	¦	A1	▫	C6	ニ	EB	♣
0E		33	3	58	X	7D	}	A2	「	C7	ヌ	EC	●
0F		34	4	59	Y	7E	～	A3	」	C8	ネ	ED	○
10		35	5	5A	Z	7F		A4	、	C9	ノ	EE	／
11		36	6	5B	[	80	μ	A5	・	CA	ハ	EF	＼
12		37	7	5C	¥	81	2	A6	ヲ	CB	ヒ	F0	×
13		38	8	5D	]	82	＝	A7	ァ	CC	フ	F1	円
14		39	9	5E	∧	83	DF	A8	イ	CD	ヘ	F2	年
15		3A	:	5F	−	84	⌇F	A9	ゥ	CE	ホ	F3	月
16		3B	;	60	＼	85	IW	AA	エ	CF	マ	F4	日
17		3C	<	61	a	86	IΛ	AB	ォ	D0	ミ	F5	時
18		3D	=	62	b	87	IG	AC	ヤ	D1	ム	F6	分
19		3E	>	63	c	88	ME	AD	ュ	D2	メ	F7	秒
1A		3F	?	64	d	89	⫤F	AE	ョ	D3	モ	F8	〒
1B		40	@	65	e	8A	is	AF	，	D4	ヤ	F9	市
1C		41	A	66	f	8B	UF	B0	—	D5	ユ	FA	区
1D		42	B	67	g	8C	⌇E	B1	ア	D6	ヨ	FB	町
1E		43	C	68	h	8D	N<	B2	イ	D7	ラ	FC	村
1F		44	D	69	i	8E	゛	B3	ウ	D8	リ	FD	人
20		45	E	6A	j	8F	CL	B4	エ	D9	ル	FE	▒
21	!	46	F	6B	k	90	-E	B5	オ	DA	レ	FF	■
22	"	47	G	6C	l	91	:A	B6	カ	DB	ロ		
23	#	48	H	6D	m	92	R	B7	キ	DC	ワ		
24	$	49	I	6E	n	93	EF	B8	ク	DD	ン		

Warranty Period

If your machine fails to function within one year after the date of the original purchase, we will remedy the defect without charge to you. Damage due to misuse, abuse, or natural causes is not covered by this warranty.

Repairs & Adjustments

Defective machinery must be returned to one of our factories which are equipped with the precise measurement and calibration devices necessary for repairs. When shipping a machine for repairs, please include with it a description of the exact nature of the problem and inform us to whether or not you have all the necessary parts for the machine.

Inquiries concerning products should be made to:

Fujikura Ltd.
Export Department
2-11-20 Nishigotanda, Shinagawa-ku Tokyo, Japan 141
Tel. 03-490-1111
Telex 03-246-6655

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PATTY TEAGUE
(803) 433-5538

4-11-90 Switches were set as follows:

S1 11000101
S2 00011100
S3 11110000
S4 10110001
S5 10011011

11000101
00011100
00001000
10110001
10011011